HARVARD ELECTRICITY POLICY GROUP
FIFTY-SEVENTH PLENARY SESSION

Austin, Texas
Thursday and Friday, December 10-11, 2009

RAPPORTEUR'S SUMMARY*

Session One.
Transmission Cost Allocation:
The Seventh Circuit Decision and The Proposed Corker Amendment

Uncertainty regarding transmission cost allocation may be the biggest single obstacle to the building of new transmission. HEPG has devoted more than one panel session to a discussion of the issue. Two recent developments, however, seem destined to change the dynamics of the conversation. In the Seventh Circuit Court of Appeals in Illinois Commerce Commission v. FERC, 576 F.3d 470 (7th Cir. 2009), a divided Court issued an opinion, written by Judge Richard Posner, reversing FERC's decision in PJM Interconnection L.L.C., 119 F.E.R.C., para. 61, 063 (2007) to approve PJM's proposal to require pro rata contributions from all utilities in the PJM region by a uniform amount to defray the costs of all new facilities with a capacity above 500kv. The Court remanded the decision to the FERC for further consideration with the admonition that the Commission must make some reasonable estimation of the benefits to each payor before allocating the costs, and that the Courts would not affirm FERC on faith, in the absence of a record on which to reasonably estimate the benefits derived by various payors.

The Amendment offered by Senator Bob Corker and approved by the Senate Energy Committee as part of Senate Bill 1462 requires that FERC only approve transmission cost allocations to payors that are measurably proportionate to each of their reliability and economic benefits. While S.B. 1462 is not yet law, the thrust of the language is in a similar, albeit potentially further reaching, direction than the Seventh Circuit decision. The Corker Amendment uses the term "measurable," which appears to have attracted considerable controversy. How does one "measure" the reliability and economic benefits of a line not yet in use? What level of precision is being called for? Is it something beyond the "reasonableness" that the Seventh Circuit appears to be asking for, and if so, how can that be achieved? Given the lack of clear direction from FERC up to now, and given the judicial and legislative pressures for increased precision in cost allocation, what are the options going forward for the regulators?

* HEPG sessions are off the record. The Rapporteur's Summary captures the ideas of the session without identifying the discussants.

PHONE 617-496-6760 **FAX** 617-495-1635
EMAIL *HEPG@ksg.harvard.edu*
79 John F. Kennedy Street, Box 84
Cambridge, Massachusetts 02138
www.hks.harvard.edu/hepg

Moderator: Upfront a few short words to set the stage in this area. A Professor of Finance at MIT told me the most important decision in the economy is the investment decisions. More so than pricing, marketing, or efficiency. If you get the investment decision wrong it's very difficult to get things right.

Transmission cost allocation is central to investments. Do we socialize the costs and spread them out amongst all users or have it structured so that the beneficiary or the cost causer, as one might term it, pays? Or, consequently as a result of that methodology do you build it at all? Each RTO has reached slightly different outcomes on this issue but it's all in the air in light of Judge Posner's decision. He decided that PJM couldn't socialize the cost for a 500 kilovolt transmission facility. There has to be an alignment between the cost, and the benefits are allocated.

In another part of the world, Congress has been devising energy legislation to promote the development of renewable and green power. Senator Corker voiced concerns that the legislation provided too broad of a license for FERC to allocate costs in these areas. He introduced a pending amendment that would define measurable benefits and costs which would be allocated proportionate the users, including reliability.

There are a lot of constituencies that are affected by this. Transmission operators find more transmission to be valuable as a source of earnings. Green power is clearly interested in finding sources and moderating the expense of building renewable power. There are states, end-users, and regulators who are looking at these costs and questioning whether end-users really do benefit from this and it's worth the expense? The agencies and the RTOs are laying out the plans and saying trust us on these things, we are expert and these plans are important and should be obvious to people.

There's disagreement all around. The only thing everyone agrees on is that someone else should pay. Or better, that someone else should pay and I should be able to make a profit.

The decision by Posner highlighted the fact that there was no debate that allocating costs to the beneficiaries was theoretically the right way to go. It makes sense, but it's not always possible or practical. A key perspective is a view that the transmission plant is deplorably exhausted and requires tremendous investment. If that's the case, then more is better and we have to make these investments. Thus, the majority of transmission investments are a good thing to accelerate. Then, the issue is let's get on with it, and not be concerned with debating the data around it.

If not all transmission is necessary then it's important to be more selective and more efficient about where you apply the investment and to seek some element of fairness there. So, if investment is the concern, then having a simple, relatively certain methodology which relies on broad-based allocations and reliability and is a backbone decision makes more sense. Relying on authorities and experts is also more efficient. If only some transmission is better, and some things are more complex, uncertain. Then consider the economics, the weak links, the priorities, the evidence analysis, and seek consensus to build.

Further, if green power is the solution to our energy issues well then build the transmission without delay. However, if innovation can come from a variety of sources that allow for us to address carbon and sustainability, then other options should be allowed to grow. Let economics play a greater role so that demand response, storage, and things we haven't thought of can play themselves out. These are the broad issues that are playing out in this debate.

Speaker 1.

The way our moderator just framed the question is quite nice: is more necessarily better or is some just better? Let me add another issue, which of those world views is going to be the world view that we implement going forward? That's an important issue underlying the Seventh Circuit's decision here and the debate over the Corker Amendment. There's different

language between the Bingaman legislation and what Senator Corker introduced. There's a concern about which part of our government, the judiciary, the agency or the legislature should be making this final decision?

When Judge Posner's decision came out it was met with some surprise and consternation in the field. I will try to explain Posner's underlying logic. Certainly Judge Posner explained himself and Judge Cudahy explained himself in dissent, but an interpretation may be helpful. The underlying concern was "Just and Reasonable Rates." The primary concern was whether the cost allocation formula was just and reasonable.

This statutory language has been interpreted for decades, and so they have to look at precedent. There are several cases. The first being an Alabama Electric case from 30 years ago. This said that a rate scheme should produce revenues from each class of customers that matches the cost to serve each class or individual customer. Ten years later in KN Energy the courts stated that all approved rates must reflect the cost caused by the customer who paid them. Another ten years later in Sithe/Independence the court reversed FERC and questioned why refunds based more closely on cost causation would jeopardize desirable pricing signals or be infeasible.

Ultimately the Seventh Circuit understands the legal standard for just and reasonable rates under a cost causation analysis. It's a legal standard. Check the benefits, check the costs, see if they match up.

But what's the administrative interpretation? Unknown to the judiciary, FERC is facing changed circumstances and trying to revise the legal standards somewhat. For instance, in Order No. 890 they allow regional flexibility and cost allocation, and when considering a dispute they exercise judgment by weighing several factors. First, whether cost allocation fairly assigns cost among participants. Second, they consider a cost allocation that provides adequate incentives to construct new transmission. Third, they consider whether the proposal is generally supported by state authorities and participants across the region. They're saying cost causation, but it is a three factor test, and that's not a hard legal standard. The nature of a three factor test is that two factors could be adequate. You could get two factors and you can go one way if they are strong factors.

Further, FERC's use of the three factor test over time is using regional consensus as a touchstone. The tender a lot of decisions based on regional consensus, which makes a lot of sense for FERC when it wants to get a lot of people to the table to agree. When it wants to force them to negotiate they tell them that they're going to pay a lot of attention to regional consensus.

At the Appellate Court, regional consensus means nothing to them. It is not the legal standard with a 30 year history. Construction incentives seems to make sense in the industry, especially if there is a concern that construction is stagnated. However, it does not pass a hard cost causation legal standard, a just and reasonable means cost benefit analysis. From the perspective of the court, cost causation has to be the primary decision-inducing concern.

The reason it hasn't come to a head for a little while is because of the doctrine of deference which the Appellate Court is supposed to defer to the expertise of FERC. They were unwilling to step in and the court has deferred to FERC's application of cost causation. FERC thought they were deferring to their 3 factor test, but in fact they often had some component of cost causation in there. As long as FERC relied on cost causation at some level and had a reasonable explanation for why their allocation scheme was consistent with cost causation, the Appellate Courts were legitimately deferring to that.

The concern in this case is a wholesale changing of the legal standard. That's a separation of powers issue, right? As soon as the 3 factor test is decided without cost causation they are changing the legal standard and that is the court's concern. As it turns out, the three factor test actually did change the legal standard all along but nobody knew it until this decision came out.

The doctrine of deference is still strong. Posner's opinion says as long as FERC has an articulated and plausible reason to believe that benefits are at least roughly commensurate with those utilities share of total electricity sales then the method is fine. Any reasonable application of cost causation will work. FERC can even presume that new transmission lines benefit the entire network by reducing the likelihood or severity of outages. They can presume a benefit.

Generally Posner was dismissive of FERC's argument. When FERC says the regional consensus supported this broad uplifting cost allocation scheme, what does Judge Posner say? He says the fact that one group of utilities desires to be subsidized by another is no reason in itself for giving them their way. That's the entirety of his analysis of regional consensus. It is not even a legitimate argument, and yet it is one of the three factors in FERC's test.

With construction incentives FERC says socialized cost is going to reduce litigation expenses which will allow more construction to be built. Here Judge Posner asks why a different method based more closely on cost causation would jeopardize desirable pricing signals, or be infeasible? Again, his analysis is minimal because those two arguments are simply not part of the legal standard.

Final, the Judge looks for the cost causation argument and FERC has not made one. It was a very broad-based "reliability is good for everybody" argument. The quote from Judge Posner: "FERC seems not to care whether any facilities in the objector service area will ever be built because the reasons it gave for approving PJM's new pricing method are independent of where the facilities are located."

There is a conflict between the judicial standard and the agency standard. FERC's reflects the practical view that more needs to be built and so the cost problem should be just spread out. The other precise legal view is simply that the law calls for cost causation and there's no reason to change that.

So what do you do when the judiciary and the agency are heading in different directions like this? A reasonable argument could be made, and Judge Cudahy makes that reasonable argument, that it's time to change the legal standard. The policies underlying cost and new transmission are significant and pressing enough that hard cost causation analysis needs to be more practical or nuanced. However, Judge Posner is right that that's not really for the court to say, it requires new legislation.

Judge Cudahy's decision makes clear that legislatures need to address this policy. He cites a House report on the Energy Policy, a New York Times article, a Consumers Union paper on electricity deregulation, and another New York Times article. Congress should be determining the standard for allocating these costs? However, there's a disagreement in Congress. The Bingaman proposal puts the burden on the utility to show that the costs being imposed on them are disproportionate to the reasonably anticipated benefits. The Corker Amendment says that FERC can only allocate costs that are reasonably proportionate to measurable economic and reliability benefits.

The Bingaman proposal is a fair description of what FERC wants to do. The Corker proposal reflects a hard cost causation approach. So, now we need a debate in Congress discussing this policy issue and coming to a conclusion. The Seventh Circuit's decision was right, FERC's approach to the policy was right. Now we need the legislature to determine what the right approach should be and get some certainty moving forward. Thank you.

Question: How do we translate newer criteria that are orthogonal to economics at some level, like reliability benefits and make them commensurable?

Speaker 1: Reliability benefits are not really measurable in some hard cost causation sense. One is you just ignore them. That everybody is getting an equal amount of reliability benefits and nobody is paying for them. Or, two, you just allocate a certain amount of the cost, say 20%, we're going to socialize 20% of the cost of these

high voltage lines. That would be a reasonable reflection of the reliability benefits that are being allocated across the system, so everybody is going to have to pay 20%. The other 80% would be allocated on a cost causation basis. Something like that might work. I understand the difficulty of trying to put a number on a reliability benefit but it should be recognized.

Question: Are there any Congressional staff reports talking more about Corker language?

Speaker 1: I have not seen much on this other than some aghast reactions to text that's been googled.

Comment: The big issue in Corker is the use of the term "measurable" because that's a term that could have many interpretations, or difficult interpretations. It's caused a lot of consternation in FERC.

Comment: Just a quick clarification. The Corker Amendment has been adopted. There aren't two competing proposals. The Corker Amendment was adopted by the committee and is the base text.

Speaker 1: Yes, that's correct. However bills come under significant evolution and adaption over the process, and parts of the Bingaman proposal could easily be incorporated into the Corker language.

Question: How did the appeal process get initiated? Was it Commission led or a legislative initiative? Why was it appealed to the Seventh Circuit?

Speaker 1: The Illinois Commerce Commission was aggrieved by the decision of FERC because they allocated approximately $200 million in cost for new transmission lines to utilities in Illinois, specifically Commonwealth Edison. Those costs were to be passed through to Illinois residents. They appealed the FERC order.

Question: They did the same thing in Indiana. What are the mechanics. Did they issue a Commission order or did they simply direct a lawyer to put an appeal in place?

Speaker 1: They did it just like a private party would hire a lawyer. They called up their counsel, and said we just got this final order from FERC and we're not happy about it and we'd like to know if there are grounds for appeal. They don't have to issue an order to do that. It's within their statutory authority. Their inside counsel called the Attorney General because they are the only one who can actually argue or litigate cases.

Speaker 2.

I'm going to discuss these issues from the perspective of an independent transmission company with no ties to other market participants. A strong component of the mission for this type of organization is to bring needed reliability and focus on the elimination of the congestion that exists in the transmission grid. The interconnection of renewables is a key concern as well.

One interesting issue is that some of these companies may have 8,000 miles of lines but one might have 22,000 MW of load, or only 3,000 MW of load. This kind of differential can become an important issue as it relates to cost allocation when building out high voltage regional network.

The first speaker gave an excellent overview the Seventh Circuit decision. It is a question whether this decision supports the Corker Amendment or the language in the Senate version of the Energy Bill. The decision by the court relies on arguments under precedent of the Federal Power Act. It says that consumers are protected from bearing costs by which they have no benefit. I would argue that the court's decision left the door open for FERC to demonstrate that there are indeed benefits to customers who are being asked to pay the bill.

Does this decision mean that broad cost allocation for larger high voltage transmission facilities are illegal? Absolutely not. There is still room for cost allocation policy to evolve. There's no nail in the coffin by any stretch of the imagination. However, until Congress acts,

we're in a state of limbo for FERC, the RTOs, etc. The reconciliation can only be done through direction of Congress.

The status quo will serve the agenda of many parties. Fundamentally, the build out of transmission has a clear role in energy and environmental policy. However, nothing can happen now until these issues are resolved.

Unfortunately, we've seen little in resolving issues like this. For instance, the 2005 Energy Policy Act, and the introduction of the DOE's Corridor Process. This is nothing more than a study to identify where the major congestion areas are in the country. There's no authority conferred that would give an agency the authority to resolve this issue. There are simply more studies that will be debated.

The Corker Amendment would require the direct assignment of transmission upgrade costs to generators. FERC would be prohibited from spreading the cost to a region or sub-region unless it can measure distinct benefits from those upgrade costs. This is difficult if not impossible because it is a network and benefits, whether it's reliability, economic, energy, or environmental benefits, are very difficult to measure and/or apportion. The Corker Amendment only distinguish economic and reliability benefits. Those alone are hard to measure those with any specificity. Certainly no one can demonstrate clearly that those benefits equal the cost, the threshold test that the Corker Amendment cannot be passed.

The Corker Amendment only considers the benefits that are identified today. A transmission network not only provides benefit today, it provides unexpected and expected benefits well into the future. No one can identify or measure the benefits that a high voltage network will produce in the future. It solely focuses on trying to calculate benefits today for assets that will be in operation for 70-100 years. This is a fundamental flaw that will not help us realize the benefits of a high voltage network. Further, if one identifies beneficiaries today it will result in free riders in the future.

The Corker Amendment is stricter than the court's opinion. The court left the door open for FERC to come back and make a demonstration of what those benefits are compared to the cost. The opinion specifies that they're not looking for things to be specified to the nth degree, they just want a rational justification. Corker requires very specific demonstration of benefit. This is a significant concern. With the introduction of RTOs, and broader regional markets the model of the past with local utilities serving local load is no longer relevant. Today there are over 500 owners of the high voltage transmission grid. If one of FERC's standards is gaining consensus then we need to find a more appropriate way to deal with this rather than strict cost benefit analysis.

This issue goes beyond transmission, it's an issue for many utilities, for states, for commissions and it fundamentally affects how we think about transmission and generation. We need a fundamental energy policy in this country. It's very difficult to make any decision on what generation resources we should focus on and how they should be paid for. A national renewable energy portfolio standard, carbon tax or pricing – all these issues affect how we plan for the future.

Ultimately there are three fundamental issues as it relates to transmission. First we need independent regional transmission planning, and a cost allocation policy that follows. Finally there is the siting issue. Three years ago, most believed that siting was the single biggest impediment to transmission development. Now, the siting issue is much less important. Most folks agree that states should have the first crack, but nobody is interested in having states, one state, one community hold up the development of transmission for the regional or national interest. So, while siting was on the forefront, transmission planning and cost allocation are now key. Independent regional planning can address that at least to some degree.

The RTOs are the facilitator of the market. When RTOs are voluntary in nature, where the members set the rules, the RTO relies on those

members to pay their bills, and members can vote with their feet then independent decision making is not possible. That's fine when it comes to the market. However, when it comes to transmission planning, it needs to be done on a broader more geographic regional basis. That would preempt the Illinois Commerce Commission from pursuing a parochial need that ultimately pre-empts the larger regional need.

RTOs that are dependent on the market function and members that make market decisions cannot also be doing independent regional transmission planning. One approach would be to separately fund the transmission planning process at the RTOs and separate it from the RTO members. We don't want to rip apart the RTO structure, it works, but we could tweak it. We need to find a way to separately fund the planning process and ensure that it's independent so that members cannot vote with their feet on transmission planning.

Cost allocation is inextricably linked to the planning function. It can never be easily determined by a group process; we need a decider on the right transmission plans. With the right assumptions, a good cost allocation policy can follow. Without having the first piece in place, it is going to be difficult to have a coherent cost allocation policy. We run the risk of having have prolonged and protracted litigation anytime decisions are made that are not in one stakeholder's interest. We have to resolve the disparity between what the law and the courts say versus the policy goals and policy desires at the state or the national level.

Question: You discussed how the Corker Amendment and the Posner decision could increase in the cost of transmission construction. What are the sources of that increasing cost?

Speaker 2: The way the system is set up today is incremental transmission investment. Every time a generator comes into the process and requests to be interconnected to the transmission grid, it's done on a piecemeal basis. It becomes a spaghetti junction of transmission investment in order to interconnect the next generator. As opposed to having a holistic transmission solution that looks at everything. Where are the resources, where are they most likely to be located, which will lead to more efficient and optimal development of transmission? As each generator comes online, an interconnection has to be added. So if a wind generator locates here, they are required to interconnect them, and the next one comes online over here, they have to build a line to there, the next one over here, they have to build the line over here. We didn't design the interstate highway system to say where is every gas station, where is every McDonald's, where is every bank and make sure that the highway goes by every bank, gas station and McDonald's. The planners comprehensively connected the major load and population centers, with on-ramps and off-ramps, and then the commerce developed around where we put the on and off ramps.

Question: So basically it's a less efficient outcome decision process.

Speaker 2: Yes.

Question: How do you envision a more independent funding mechanism? Can you really get independent funding?

Speaker 2: It would be similar to how we fund NERC. NERC is the reliability organization and it is a mandatory assessment. We all pay a mandatory assessment to belong to NERC and for NERC to do what it does.

Question: Is that a greater socialization?

Speaker 2: We all pay mandatory fees, whether state commissions impose assessments on their utilities, FERC composes assessments on utilities. I think it has to be an assessment that is not bypassable and you cannot opt out.

Question: Can you discuss what measurable means in the Corker Amendment? It is a tighter standard but it doesn't say you cannot do estimates that address future benefits. Your interpretation of their language seems to be a very restricted view. I'm just curious why you draw that conclusion, as opposed to seeing the language in broader terms.

Speaker 2: Well, honestly it's because I think when you look at who's proposing the language, who's behind it that amendment, who wants it?

Question: You said the function of RTOs are to run competitive markets. However, they also have to maintain reliability, whether in real-time and also forward-looking. That's where the transmission planning element comes in. How does reliability fit into this picture?

Speaker 2: The point I was trying to make was that the governance structure, the lack of independence of the RTOs, does not facilitate independent transmission planning. RTOs are a very good structure, but the transmission planning function should not be voluntary. An RTO should have the ability to make independent decisions on transmission planning without the fear of members leaving. Independent planning under that governance structure. They do have an important reliability function. Both the market and the planning function, go hand-in-hand. I'm not suggesting that we unnecessarily separate those. The independent planning process cannot be held hostage by threats of withdrawal.

Speaker 3.

In the marketplace, there are a lot of large and small, vertically integrated, investor owned utilities, there are large and small public power and generation, public power entities who are generation and transmission entities, there are retail only load serving entities that are investor owned, there are small public power load serving entities, there are independent transcos, there are independent power producers, there are ITOs, there are ISOs, there are ICTs and a bunch of other acronyms, there are a lot of state regulatory agencies, and there is, of course, FERC in this marketplace.

There are competing objectives among a lot of these entities. The key is to try to identify and promote the solutions which create the very best outcome for wholesale and retail customers. Certainly, there's not likely to ever be a consensus developed on this whole topic of cost allocation. So who has the jurisdiction? In some cases FERC has clear jurisdiction over this topic of cost allocation, but states play an important role in the jurisdiction over cost allocation.

A general approach to this problem will not work. Ultimately one has to get down to thinking about some specific example; some defined geographical limits, a specific set of assets, some defined transmission systems and generation assets. Who are the customers, where does the regulatory jurisdiction lie? It really becomes a regional issue, not a national issue. It cannot be resolved nationally.

It really matters what type of transmission investment. Is it a generator interconnection investment, the extension cord from the generator to the grid? Is it a network improvement kind of investment that has to take place because a generator connects and exists electrically? Is it a transmission improvement to provide some kind of service to a micro generator deliverable or to a given load? Is it a reliability improvement? Is it load growth related? Is it an investment because load is expanding in a given area or is it some type of speculative improvement to allow someone to participate in the marketplace if the price is right at a given time? All those types of investments perhaps have different treatment from a cost allocation perspective.

The Corker Amendment can work actually. The beneficiary can be clearly identifiable and obviously should be held accountable for the cost. If one can answer this question, why is this specific investment being made? Why do you want to make this improvement? Why do you want to build this line? Why do you want to build this substation? If those can be answered then the question is simplistic. This is because identifying the beneficiaries comes directly out of answering those questions. If the questions cannot be answered then it's not clear a project is needed. The state and the FERC policies that exist today are completely adequate to identify the beneficiaries and to allocate the cost.

The concept of measurable is the focus of much of the debate. To ultimately be able to measure

and identify a beneficiary, you really have to start with some base case, a base case. this is found in transmission planning. Most entities, most RTOs, most large entities have a transmission plan in place that covers from the present forward from a ten year period. Those transmission plans reflect expected load growth, generation dispatch, and expected generation resources that are going to be utilized going forward. Once those are in place, a plan will determine what problems there are going to be and what investments have to take place to ensure power is delivered to customers. It starts with a base case.

There is ample room for debate about the components go into that base case. For instance, load forecast. Well, who knows what the economy is going to do over the next ten years? Fuel forecast. Who knows what the price of natural gas is going to be in 2017? I don't think anybody does. Nonetheless, a foundation for the base case needs to be set so that you can identify a beneficiary. Next, what is the stimulus for the next transmission investment? It might be a new generator or a renewable resource in some location, whatever. One can inject that change, and identify what improvements have to be made. If those improvements don't exist already in the base case then that's a source of causation, and a source of causation is a beneficiary.

The base case is the critical component for moving forward, and identifying costs and benefits. If you cannot ultimately get comfortable with the inputs and the foundation of that base case you're never going to ultimately answer the cost allocation question. Ultimately, customers are going to pay for this investment wherever it is. Thus, it's extremely important on a region by region, on a regulator by regulator, on a company by company basis that we work hard to try to identify the right parties to pay for an investment.

Question: What's your definition of a region?

Speaker 3: In my case it's the regional planning effort to take place today. I'm familiar with the way they've set it up in Georgia around Southern Company. I think probably the FERC 890 definition might be as good as any.

Question: Well, down south there's some big interconnections to the north and they interface the south; they depend heavily on those. It might be better to look at this as the interstate highway model. in a sense. For instance, Georgia uses federal tax dollars for a highway to recruit industries. When Florida lost its 3600 megawatt interface to Georgia years ago from a fire, it had implications in the grid and in prices in the Midwest. Local regions have effects that go beyond their regions.

Speaker 3: I don't agree with that.

Question: If we get national mandated RPS standards, then Georgia is going to be a little more interested in where they get their renewables right?

Speaker 3: Absolutely. If they get mandated RPS standards, then they'd like to be able to work within their states and public service commissions to identify the set of resources that is most economical.

Speaker 4.

I will focus on issues within ERCOT today, and from the perspective of transmission companies. Some have proposed the I-765 plan which is a proposal to build a national network of 765kV backbone transmission modeled after the interstate highway system. The idea that you build it is based on a vision of what is needed rather than a reaction to what the situation on the ground demands.

Let's discuss the Seventh Circuit decision. It's important to understand what the court did and did not say in that opinion. One thing it did say was that cost allocation needs to be focused on cost-causation and beneficiary pays principles. The court seems to argue that cost-causation and beneficiary pays are really the same thing. If you look at who benefits from the transmission project they are the cost causers, they are the parties that need to be allocated the cost. The

other thing the court said, and it's a fairly ordinary common judicial holding and review of agency decisions, is that FERC simply didn't explain itself well enough, and it needs to be sent back for more explanation.

The court seemed very focused on the regional issue between Eastern and Western PJM, and focused on the information that suggested that the transmission facilities above 500kV would really only benefit the Eastern PJM. There was no discussion of benefit to the Western portion of PJM.

Second, the court's view of what FERC needs to do to fix its inadequate explanation. "We don't suggest that the commission has to calculate benefits to the last penny" or, for that matter, to the last $1 million or $10 million or perhaps even hundreds of millions of dollars. The court is not asking for a very precise cost benefit calculation, it doesn't have to be within the range of even $100 million. The court even goes on to say if FERC cannot quantify the benefits, but it has an articulable and plausible reason to believe that the benefits are at least roughly commensurate with the costs then that's fine. There may not need to be any kind of quantification at all. An articulable and plausible reason why the benefits and the costs are aligned should suffice.

The court goes on to say FERC can presume that a new transmission line benefits the entire network by reducing the likelihood or severity of outages, but that presumption cannot avoid the duty of comparing the costs assessed against the parties with the burdens or the benefits to that party. The dissent is worthy of mention, and seems to have had an effect in the majority decision. The majority's careful description of how much discretion FERC really has on articulating the benefits of the lines probably resulted from the critique in the dissent.

What are FERC's options after the opinion? One option is to just develop a record supporting the original decision. The court left considerable leeway to furnish a more thorough and developed explanation of why the cost allocation formula is justified. A second option is modify the PJM tariff and require a more quantitative analysis. FERC could provide a direction about how those benefits should be assessed, it could describe what categories of benefit should be analyzed, and how they should be analyzed. It could either adopt the same cost allocation or a different one based on that analysis. Finally, FERC has an option to use a general policy or rulemaking in place of a litigated case to develop this direction on cost benefit analysis.

Until FERC provides further guidance, RTOs have a lot of flexibility to make judgments about how to go about this process. They can look at whether they need to evaluate individual transmission projects or whether they should evaluate them as packages since transmission solutions often come in packages. They can make judgments about the time horizon over which they evaluate the costs and benefits of a transmission project. They can make judgments about what benefits ought to be considered in the analysis, how broadly or narrowly those benefits ought to be looked at. And finally they can make judgments about how specific or non-specific the benefits analysis would be as they look out five, ten, twenty years or longer.

Bottom line is that the court opinion really doesn't mandate that FERC or RTOs adhere to any particular approach to benefits and cost allocation, nor does it require a particularly detailed analysis. Instead, FERC's obligation is simply to insure that there is a reasonable consideration of the benefits and an explanation of the relationship between those benefits and the cost allocation decisions that it makes.

Let's look at the Corker Amendment. The key focus in the Corker Amendment is on the final few words that require a measurable analysis of economic and reliability benefits. What do those words mean? What does measurable mean? How limiting is the focus on economic and reliability benefits? Does it limit analysis of other benefits that may be associated with transmission projects? It seems to limit the scope of possible beneficiaries of transmission projects, and seems to substantially erode the administrative authority and discretion of FERC to analyze cost allocation issues.

The Corker Amendment is likely also to result in lower voltage transmission development, increased development of HVDC lines, and the types of facilities that are more amenable to strict product cost analysis. There will be less development of higher voltage backbone type facilities that are less amenable to that analysis.

What is the appropriate role of the legislatures and courts and agencies in cost allocation decisions? The legislature, up until now, has settled for a *just and reasonable* standard. The development of what that means in cost allocation situations has been with the courts and the agencies. In the case of any precedent, that precedent cannot evolve or develop, to address new and different situations that arise. It's entirely appropriate for agencies and courts to reexamine what *just and reasonable* may mean in a modern transmission system.

Here are a couple of illustrations that Lisa put together, her view of the future under the Corker Amendment. I'm not sure where she came up with them, but in her view

The Corker Amendment will likely encourage rigid cost benefit analysis. This evaluates systems on a line by line basis, is not really in keeping with today's needs to build and support a robust backbone transmission system. Instead, it will encourage the development of single purpose transmission facilities and the multiplication of transmission facilities.

An example is the Eastern RTO planning process that focuses on production cost studies. There are significant benefits of transmission that are not included in that analysis. A couple of those are an enhancement of competitive generation markets, and environmental and renewable access benefits. A recent Brattle Group analysis suggested these omitted benefits often are double the benefits that are shown in a production cost analysis.

This debate is like comparing toll roads versus open access freeways. If RTOs fail to develop long-term solutions on a timely basis, the market will supply some of those solutions. Some of those solutions will be merchant lines that are built to avoid the congestion that exists on the public transmission system. When they see an increase in the merchant anchor tenant model that they use in the natural gas pipeline business, we may see a preference for high voltage DC lines that can be more readily analyzed on a production cost basis.

The result of this type of development is lines that are built to catch up with need and are often at capacity as soon as they are constructed rather than lines that are build to get ahead of need. The bottom line is more, not less, transmission will be constructed. It will take more right of ways, result in a less efficient transmission system and more costly energy delivery system. By contrast, development of an open access system provides broad system-wide benefits and flexibility over the long-term. We need to consider all the benefits, not just those that are easily quantifiable. The best storage facility for energy is an integrated grid without bottlenecks that allows free flow of generation across broad distances.

What if the Seventh Circuit opinion is upheld? Commission ratemaking and cost allocation decisions will still be governed by the same *just and reasonable* standard, and the same procedural requirements that rely on substantial evidence to support decisions. RTOs that are developing cost allocation policies are not limited to considering only those benefits that can be easily quantified. The court is not requiring exacting precision. It was primarily concerned with FERC's failure to supply any record support for its decision. RTOs going forward should articulate the full range of benefits of new transmission facilities, not just production cost savings.

Question: We've heard about the metaphor of the US highway system. But the US interstate system was built by federal funds and owned by states. I presume that is not what we should eventually evolve to.

Speaker 4: No, it's a better metaphor for the type of planning process that would be optimal. It's the idea that you look out further ahead and you build something that is more long-term vision of

what the system ought to be rather than a reactive vision which is solely incremental and far less efficient.

Question: In the Federal Power Act, could you point to more language that defines trivial, it is a very broad term. Are there actual tangible metrics to measure what trivial means in the Federal Power Act?

Speaker 1: There was actually a comment by Judge Posner in which he was illustrating trivial. The intervener's counsel conceded at oral argument that $1 million worth of benefit for a cost of $480 million would not support a causation argument. That's at the outer range of what we have to go on in terms of trivial.

Question: How does one precisely define who the beneficiaries of any transmission project are?

Couldn't we interpret the language of the Corker Amendment to simply mean measurable? One can look at the output of an optimal power flow model under various assumptions under transmission planning, look at who is impacting the flows on a particular line that's measurable, consider those folks beneficiaries and just move forward? I would be curious as to other interpretations of that. Maybe I'm just being naïve. Is there something more complex behind the Corker Amendment than that.

Speaker 1: I'll start with the beneficiaries. In the litigation there was a *beneficiaries pay* formula in place. FERC had approved that formula for all transmission lines below 500kV. They used a DFACs [Direct Facilities Assignment Charge] analysis to determine beneficiaries. It determines why are you building these lines? What is the purpose of building these lines? Whose congestion are you relieving? For the purposes of the Seventh Circuit case, that's how the beneficiaries of the 500kV and above lines would have been determined.

There are concerns with the term measurable. In the dissent, and from the interveners, we heard that you cannot measure the overall reliability benefit of a line to far-reaching parties who may not directly benefit. We heard from someone earlier discussing how a line goes out in Florida and the effects are felt in the Midwest. Those kinds of benefits just aren't measurable. Those people won't pay under the Corker Amendment. The term measurable to me means you can quantify. The question is whether people should pay for a benefit that exists but which is not measurable.

Speaker 2: Measurable does mean quantifiable and it only allows you to measure economic and reliability benefits. In 2003 when the blackout occurred, the first system to go down was in Michigan. We all know that blackout cascaded all the way to the East Coast and to New York. So does that mean when a transmission line is built in Michigan that New York should now pay for it?

There was an impact in New York when the Michigan line went down. However, nobody in New York or the East Coast is going to start paying for projects in Michigan. It is impossible to take broad system benefits and try to assign them down to the last penny. For those who don't want the investment for whatever reason, they'll use some other assumption through the transmission planning process to show that if you change the assumption in the planning process you get a different cost allocation outcome.

Transmission planning has great importance in the ultimate cost allocation. It is predicated upon two things: what is the fundamental problem that you're trying to solve, and what are the assumptions that go into that? Future assumptions, load growth, generation dispatches all go into it. Anytime you change one of those assumptions you're going to get a different outcome through these sophisticated production cost modeling systems, and thus, a different cost allocation. Whomever doesn't like the answer is going to continually come back and demonstrate that if this happens or that happens you're going to get a different quantification. This process is the way that a project gets stopped. In my mind we have to return to what is the fundamental policy, what is it we're trying to achieve? Right now, need is typically defined as either a reliability or economic benefit. Until we had the

introduction of RTOs, there was no such thing as reliability and economic benefits. Any transmission planner would tell you that you cannot separate the economics from the reliability, they are on a continuum.

The problem we have now is that we're now introducing renewables and environmental policy on top of reliability and economic. How does one measure who benefits from a renewable resource coming online and who pays for the transmission to deliver that renewable resource? With wholesale markets, whoever may be the customer today that signs up for that capacity from that wind generator may not be the one tomorrow. It may be a different set of customers tomorrow that get a benefit of that renewable resource. Under the Corker Amendment that future customer wouldn't be assigned any of the cost.

Further, consider the context. Transmission represents 5% to 7% of the overall electric bill. Generation is typically 60% to 65%. We are trying to exact cost on a tremendously important component that is a small percent of total cost. DOE just announced all of their grant recipients under the stimulus bill, $100 billion in DOE funding. People say they're worried about socialization? That is the ultimate in socialization or uplift for local benefit. All of these Smart Grid projects are for local benefits. Now, how many utilities want measurable and quantifiable benefits but still applied for those socialized Smart Grid grants? Did they complain about socialization then? It is $100 billion of cost socialization for the ultimate in local benefits and nobody is complaining.

Question: We didn't decide whether the money was going to be given out or not. It's not the right thing to do. But somebody other than us made that decision.

Speaker 2: Right. That's why we need Congress to make the decision, because if it's left in the sandbox, none of us will ever agree.

Question: There is a bifurcation between the Brattle Report saying we didn't quite include all of the benefits and maybe we could redo the calculation. This is about whether we got it right within $10 million or $20 million? Is that appropriate to make an allocation. On the other hand, Corker wants to make sure we don't have any people for whom the benefits are $1 but who will be charged $100 million. There is a big difference between those two worlds. Is the situation one where there are beneficiaries who getting $1 million and paying $100 million? Or one where beneficiaries are getting $50 million and quibbling over whether they are paying $20 or 21 million? Which is the real problem?

Speaker 4: Transmission improvements benefit everybody on the grid and it prevents the need and development of transmission facilities to endlessly debate how much a project benefits each group. In the long run, the sum of transmission projects is going to benefit all of the load on the grid. Uplifting costs is a much more efficient way of getting that transmission built.

Question: Can we evaluate the sum of the benefits for everybody? Or is that beyond us as well?

Speaker 4: I don't know that all these benefits are quantifiable. In fact, a lot of them are not quantifiable.

Question: So on what basis are we doing transmission planning?

Speaker 4: It needs to be done on a consensus basis by engineers who are planning a grid and not by companies that have their own interests to advance and not by fragmented decision makers that prevent an end solution.

Question: However the engineers also cannot figure out what the benefits are vis-à-vis the costs, is that right?

Speaker 4: I don't think one can quantify all of the benefits of transmission.

Speaker 3: I don't really know the answer to your question, but the point of debate is who decides what is the best answer for the customer? Do we let big brother decide the best

generation source, or the best way to deliver it? Or do we let the current system of accountability decide what's best? It is fragmented, and local, but there is ultimate accountability to the people who make the decisions. Where is that decision going to be made? One set of people believe the wind from the Midwest and the interstate overlay is the answer to all our energy questions. There is another group that say I'm not so sure. Decisions should be with state regulators and companies where the local accountability is to customers and then work through the process to get it delivered. That is the crux of the debate.

Question: How can you make the decision that a particular transmission investment is beneficial and then rely on a regulatory process to make people pay for it who disagree with you? That's the essence of the argument here. If they agree, and are prepared to pay for it, it's a merchant investment and end of conversation. There are examples of those projects out there.

One argument is that we don't have to quantify the benefits because we know it's going to be terrific. The other option is to quantify benefits, but it's complicated and controversial. If it is complicated and controversial then it's not so obvious that it's a great idea. At that point it's not a problem because maybe we don't actually want to build it if it's that close a call and people don't agree that it is a benefit. If it's so obvious that it's a good idea, then why do we have to cram it down people's throats.

Speaker 1: If it's the interstate highway, Congress said we're going to build it, and they funded it. The Seventh Circuit has tried to provide flexibility within a framework. Identify why you're building this, who is going to benefit, what those benefits are. You don't have to do it the nth degree, or quantify it extensively. They have to provide an articulable and plausible for assessing those costs. They cannot be trivial. Your first solution needs a policy at the national level that says this is the way forward, there are broad benefits that some won't wish to pay for but we're going to incorporate them. Absent that, we're left with a framework to get the job done without quantifying to the nth degree. The Corker Amendment goes further towards that quantification question.

Question: That is the mechanism for doing it if we decide we want to do that. Congress can pass a law that says build 500kV lines anywhere you want them to go and make people pay for them. How would I advise my senator whether or not to vote for such a thing? How do we know whether or not that is a good idea?

Speaker 1: You determine if the country needs more infrastructure built. If you determine it's a crisis and we need more, then you vote for the Bill.

Question: OK. Imagine we definitely need more but I cannot quantify how much more we need but I know it's a lot? [LAUGHTER] That's the conundrum I'm wrestling with.

Speaker 2: If we had a national energy policy it would be something we could plan towards. It certainly wouldn't give us the details of how much and where and who should pay. Fundamentally again, what's the problem we're trying to solve? Is it a reliability issue? Or is the transmission grid severely congested and customers are paying the tune of hundreds of millions, billions of dollars on congestion rents and, if we had more transmission it would outweigh the continued congestion costs? Or do we desire renewable resources and need more efficient, effective resources to market? Perhaps the benefits of having those is better than importing X billions more tons of oil or burning more coal? We need to determine our goal, and then think broadly about how we want to accomplish it.

I do think we need to consider high voltage transmission is a public good. This is still predominantly a monopoly business, and it's always been conceived of as a public good. Why is it a monopoly business? We can build a merchant line from here to there and there's a customer on the end who we can identify should pay for it, but do we want transmission lines traversing all across our community, our state? There is a higher level where there is a benefit of a monopoly business implementing one set of

wires that are planned for the bigger, broader benefit of the country as a whole. It's a public good and has to be approached that way.

Speaker 3: We need a specific example. We need to define what we're trying to solve. We can't identify a beneficiary without determining what we're trying to solve. Then the answer is easy.

Moderator: Let's turn the question around. Clearly transmission benefits a lot of people, it's a shared resource, there is a clear need for building transmission, but it cannot be measured easily, if at all. Is it possible to make a bad transmission investment? And, if so, how do you identify that?

Speaker 3: It is possible to make a bad transmission investment. Investments that come out of the transmission planning process with a vision of solving a specific problem given a specific set of assumptions work well. Certainly they are a long lived asset and most would have value down the line. The question is would you be making an investment today that could be deferred for some point in time and the total economic costs would ultimately be less?

Thus you might never make a bad investment, but there might be other more useful public goods that you could be spending your money on. You could certainly invest more than you need for some finite period of time.

Question: My perspective is from California. There is an ISO. I think that's the last monopoly. We need to focus on the grid operations based on other's bids and offers, and the grid planning based on a competing set of solutions. We need to couple those logically because you want one to inform the other. The process should ask what are we setting up in the future based on what we know today? It's the same for The Cal ISO or for Southern Company.

In California the solution set of transmission is not a monopoly business. There are all kinds of competing transmission. They are confused about what it means to be merchant. They've said if you're privately funded then you're merchant. Third-party funded means you are not a utility investment or an IOU investment, but looking for rate-payer funding. There are distinctions between merchant and third-party. I'm concerned about a third party coming in and requesting ratepayer funding because they are providing some public good.

The reliability is piece is pretty straightforward. The economic piece has more uncertainty but models can show where transmission is beneficial. With economics, I think it is possible to figure out a way to have beneficiaries pay.

Renewables are difficult. What are public policy benefits of things like renewables? California has a state mandate to reduce once-through cooling. So there, are the beneficiaries the state, or some subset of the transmission planning process. If California has renewable energy zones defined like Texas, and transmission lines are necessary, who is getting the benefits? And how do we measure them?

Speaker 2: I don't have an answer. If third-parties are coming to the table it's because either policies aren't established or investment is not being facilitated. Therefore they're looking for creative solutions to address archaic or badly set up regulation. There are examples of that all over this country, if not at a national level. We are operating under a system that no longer really meets the needs of the issues that we're dealing with today.

Speaker 3: I'd go back to the planning process. Needs are met through the planning process and determined by a lot of different things. Reliability, national or state laws. If there is some state law that dictates some social good, then fine. If an investment comes forward to a regulator, and was justified by one of those needs then it can go through the planning process and the regulator can determine it's appropriate. If it's a social good, determined by a law to be for the greater good of the citizens of California then somebody has determined that they should pay for it. If it's speculative, something somebody wants to build that doesn't meet criteria in the planning process, then it should not be built.

Question: If there's a renewable portfolio standard that exceeds the state, does that make the case for socializing transmission?

Speaker 1: No, if you have a state law that says you need a renewable portfolio, then build transmission to satisfy that state law.

Speaker 3: That question comes up differently in California. What if you are in an area and a line has to cross your territory that doesn't benefit your constituents, it's just a pass-through? Somebody wants to move power from point A to point B, how is that handled? And I don't know how it's handled in California, but if somebody asks for service across the Southern Company, they're obligated to build that by FERC tariff. And the cost recovery is handled by FERC tariff. There is a revenue stream associated with the transmission service that covers that investment, but the state doesn't have any choice whether to build it or not. They have to go forward and build it. It would not be included in their retail rate mechanism. The state would seek revenue recovery at least for some period of time.

Moderator: Because you'd recover the revenue from another source.

Speaker 3: They'd recover the revenue from a wholesale tariff from transmission service. However, in California, in siting, how do they justify to some voter or constituent or governor or politician that this a line has got to be sited because FERC says they don't have an option to provide that service? That's the difficult question.

Question: What do you say?

Speaker 3: Go to Washington, that's what we say. That's a touch problem.

Question: That is the next order problem in California, they're trying to do Western renewable energy zones and there isn't a Western regional planner to sort out any of this.

Speaker 3: That's why all these regional-like entities have come into being to try to address that amicably among all the various states for that very reason. I don't know that this all can be resolved, but it's a tough problem.

Question: We've heard about highway analogies several times in your presentations. In the highway system, we pay for the highways through taxes but get to use the highway for free, with some exceptions of course. Let's say we're successful in socializing or uplifting the cost of new transmission for renewables in the West to get to the East. We build a line from North Dakota to the East Coast. That line has now created additional capacity which is being paid for by everybody through an uplift charge. Does everybody get to use that line for free? If there are FTRs created, who gets those financial transmission rights? Or, if there is physical capacity created, who gets to use the physical capacity? In the past, we've used the tariff system to allocate capacity. But if this is being paid for by taxes, like the highways system is, who gets the rights to use that line? Is it first come first serve? How does all that work?

Speaker 2: That has to be determined. Consider the Green Power Express project as an example that traverses the Upper Midwest. MISO goes through an extensive process to determine who gets what rights. They have procedures for assigning rights and FTRs.

Question: If I'm paying for those rights, say in the Georgia power service territory and I'm paying for a line from North Dakota to the East Coast, do I get some rights to use that line?

Speaker 2: That's certainly one of the issues, yes.

Question: How would that occur if MISO is making that decision?

Speaker 2: That's why there are inter-RTO processes in place. When you talk about regional or interregional cost allocation, the RTO at the region level should not be making the decision for an interregional cost allocation. Parties have to come together to work it all out in a planning process, at the front-end of it. You cannot have MISO making a decision that they're going to

allocate costs to Southern or PJM region without them having a seat at the table.

The bigger issues is whether we get to have a high voltage transmission network. Assessing the environmental, congestion, or reliability impacts of not having them. Are those costs we continue to pay? Do we move forward now, or 20 years from now?

Question: If the federal highway system is the appropriate analogy, why not use the same model for the high voltage transmission system? Why not have the government build it, have people pay for it in their taxes and then let the government decide the allocation? Would you support that?

Speaker 2: No, this is not a capital investment issue. It's not a capital problem. Transmission can go to the capital markets and raise equity, and the private sector can do it more efficiently, more effectively than the federal government. However, if we're talking about potentially the federal government assessing a mechanism by which to impose how we all pay for it, that is up for debate. The federal government cannot invest hundreds of billions, if not a trillion dollars, more efficiently than private companies can.

Question: However, it's not private investment, it's ratepayers. I know they can raise the capital. However, it's the ratepayers that are going to be paying. It's all toll roads, and everyone has to drive on them. In the end ratepayers are going to be reimbursing the builders for the projects.

Speaker 4: Let me take a little different angle based on the experience in Texas. The lines would be open access lines and available to everybody. There would be no allocation of capacity. In Texas, with limited exceptions, there are no priority rights to transmission. When it gets full it gets congested and you get traffic jams. We need a mechanism for curtailing that and getting more transmission lines.

Question: I'm curious about the motivation of the litigation by the Illinois Commission. Was it really driven by the cost allocation issue for transmission or was there another reason behind it? Another perspective is that Illinois would rather that these transmission lines don't get built so that low cost nuclear and cheap coal is trapped in the state?

Speaker 1: That's a very insightful question. [Laughter] The motivation for litigating the case was the socialized costs to be imposed on Illinois ratepayers of the new high voltage facilities. Now, it is true that if you built those facilities some of the energy resources that are currently in Illinois would flow East and prices are going to go up. That point was made explicitly to the Seventh Circuit. The lines would be a negative for Illinois. The cost of their energy actually increases because the energy goes the other way. That point was not concealed. They would lose both ways under the socialized cost allocation. They focused on the beneficiary pays basis of it, and not on the increase in cost. They never quantified the losses in terms of cost increase.

Question: One clarification. There were two other appellants, the Public Utility Commission of Ohio and Dayton Power and Light.

Question: If the Corker Amendment passes question and I'm a FERC commissioner, what do I do with the term measurable? The first question is measurable when? Are we stuck with who's the beneficiary today, even though we know over time the beneficiaries will change? Do I look at in the short-term? Who benefits today by what calculation? Do I do it over the long-term because we all know beneficiaries will change over time? How do I deal with that?

Speaker 1: It is a new concept that's being introduced into the allocation process. It's a new statutory term and you would go at it from a statutory interpretation approach. Future benefits are a problem, even in the Seventh Circuit case. Nobody knows in the future if Illinois might benefit from the lines, but they couldn't measure them.

Question: That's part of the difference between what Posner said and what Corker said. There's an enormous difference. Posner recognizes the

subtleties. I'm not sure the Corker Amendment does.

Speaker 1: I think measurable is pretty clear. What it's saying is quantify. That's what it's intended to mean. We cannot identify future beneficiaries with precision, so you cannot count them under Corker. It takes uncertain future benefits and forces a DFACs analysis or some corollary to that.

Moderator: How would it address beneficiaries changing over time? Does it permit that? Assuming you could measure it, but now you measure a change in benefits over time. Does it change the allocation?

Speaker 1: If, in the future before lines are paid for, new beneficiaries emerge and the purpose of the line has changed, those people would then be asked to chip in. It would require measuring them. You couldn't measure them in advance.

Question: That's part of the problem. With the Corker Amendment everything you have to do is being done in advance. Even before you build the line, you're being required to measure it in advance. How is that any different than future beneficiaries?

Speaker 1: They used DFACs analyses which did purport to measure why these lines were being built. They measure who was using the old lines, who was causing the congestion and who was going to use the new lines. The assumptions that go into those numbers are up for.

Speaker 3: The burden of proof, if it were to go through, is going to rest upon whoever the administrator of the tariff is. Typically how that works is somebody will make a filing and then a bunch of other people will pile on relative to intervention, and then it will follow that FERC process. Either the person or entity making the filing will do a good enough job of convincing the interveners that, in fact, whatever technical case they have to make is adequate and will reach some agreement in a settlement or FERC will rule based upon the evidence in the filing. It's either going to be negotiated and clear to all those parties involved, or FERC will ultimately have to make the call based upon the evidence presented by the people making the filing.

Question: The points about winners and losers are totally underrated. People talk about beneficiaries pay versus socialized as if the socialized version is that you weren't benefited by it but you're going to help pay for it and eventually it will be good because more transmission will be more robust and it's a win situation. However, let me just quantify it in some New York terms. A recent study shows that if you alleviated congestion into New York City it would save $75 million a year. So if we could build a line for less than $75 million we should do it. Clearly in New York they'd agree on beneficiaries pay, the people in the city would pay for the transmission and it would be a win-win situation on the face of it. However, when you go behind the numbers it turns out that the people in the city benefit $200 million, the people upstate end up with costs of $125 million. So if you want to go to the socialized approach basically you're saying to the upstate people, one, your prices go up, two, you get the really ugly lines over your landscape and, three, by the way, you can help pay for it. [Laughter]

They had a line proposed. 1,500 people show up to talk about that line. Four people were for it, OK? So this idea of a beautiful map that showed at least three lines heading directly into New York City traversing the landscape, they're going to socialize this and maybe the people that get socialized will be just a little bit unhappy. It's majorly unhappy. It's just going to move the venue for opposition to the federal government. Some here are expressing it's good for us, it's the interstate highway system, it's a win. How do you explain that to people who don't win, at least in the first instance?

All the studies showed that the incremental cost of the transmission was not worth the alleviation of congestion, on a production cost basis, not taking into account other factors.

Speaker 2: Without a policy to guide us, the market will ultimately respond. This idea of transmission lines traversing the countryside that we all have to pay for and it's hard to say

whether we get any benefit out of it. The flipside is that if the market responds and merchant lines traverse the countryside, only one person will get a benefit out of it. From a policy perspective, is it better that we have a network in place that everyone can benefit from or is it better that the market ultimately ends up responding bigger, public impacts and fewer or more narrow beneficiaries?

Question: The merchant lines won't be looking for standard recovery. I guess it depends on that model you're talking about. If the merchant lines get built with rate recovery that's one thing, but if the merchant lines get built at their own capital risk then the only ratepayers paying are the ones who are truly getting the benefit. Like the two lines built from New England and PJM into New York. They're willing to take those risks and collect their monies via contracts but the ratepayers aren't paying that.

Speaker 2: That's a ratepayer perspective. There may be legislators who say this line is crossing through my backyard and I'm getting no benefit out of it. There are other broader public policy issues as to who is being impacted versus who is getting benefits. If we don't try to solve this issue we will end up being driven to a merchant model, with large impacts.

Speaker 4: Your question seems to assume that the people in Upstate New York have a right to this generation that's apparently trapped in their area.

Question: They certainly believe so. [Laughter]

Speaker 4: I'm sure they do, but I don't know that that's a very good basis for deciding whether to build transmission and relieve congestion.

Speaker 1: You could always pay them more, right? Isn't that how the market would dictate it, right? Just pay them more until they say OK, now you can build your line, until it gets close to that $200 million that New York City is benefiting.

Question: They don't have a right to the generation. One could build a transmission line if one was prepared to pay for it yourself. If you assume the risk you could, right?

Speaker 1: Right.

Question: It just turns out it's not worth it. [Laughter]

Speaker 1: Even if it's worth it there's a whole new set of losers to deal with.

Speaker 3: In most states how would you ever site it? Most sites require a demonstration of public need for eminent domain, unless you have some higher authority, so how do you ever site it without demonstrating public need?

Question: In Texas, the transmission developers basically went out and negotiated with each individual landowner. They constructed it in nine months. It's a public/private partnership. If you look at the ERCOT ratepayer lines versus private lines, together collectively we are now seeing new levels of wind penetration in Texas.

Let me comment about a private line not paying for the ratepayers. In essence when a power authority brings a PPA to the Commission for approval with a transmission component it's a shrink wrap deal. The consumer is paying for it because the generator and transmission builder do not get financing without that PPA. It's just a different form of rate-based recovery. The Long Island ratepayers are paying for it.

Question: The beneficiary pays approach has an effect of putting a real cost in play so that people who are going to be paying can make a decision. So a utility considering an offshore wind project, or local solar projects, which are quite expensive, can assess what their ratepayers are paying. So if you've got wind or other resources from the west that have a free ride into the east that's going to make the overall cost seem less compared to renewable resources closer to home. Socialized lines from west to east give the western renewable energy a cost advantage. It will make local resources seem more expensive.

Speaker 2: Is it unfair advantage that customers in New Jersey are paying less or what part is unfair?

Question: Does energy from Montana seem cheaper because you're only paying for the wind and not transportation, versus the cost of putting solar panels on our electric poles. Renewable resources built within a state has economic development effects. States want to encourage these resources. The socialized transmission just hides the cost of transportation.

It may be that it's still cheaper to bring it from Montana, but the entire cost should be considered. That part of the discussion just seemed to be missing today in the presentations.

Speaker 2: We do need level playing fields. It's the same thing with generator interconnection costs. When a utility owns the generation, the cost to build the transmission, interconnect that generator is included in their regulated and recovered rates. When that generator sells generation outside their footprint the cost of the transmission is not born by the real customer because it's already being recovered in regulated rates. That gives those utilities a competitive advantage, they can sell their generation without the transmission cost being reflected in the price. It's not a level playing field. If we can get to the point where everybody is on a level playfield, then consumers can make the best decisions. However, our regulatory models have hidden prices every day in the marketplace.

Question: One of the things that's missing is that transmission essentially becomes a substitute for other types of generation. The extra high voltage transmission could have the effect of crowding out the local renewable generation opportunities. Building a big transmission network has an effect on whether or not generators can come into the market. It's not a level playing field, but actually nudge some players out that otherwise would come in.

Speaker 2: If the country builds a high voltage network it will have a significant impact on what generation gets built and dispatched. A transmission network means you're going to drive some generation to liquidation in the marketplace. It's going to be a dog eat dog world and someone's generation is going to be displaced. Transmission is not a substitute for generation. Transmission is simply a facilitator of the market. Transmission does not produce electrons.

Question: The question was asked can we over invest in transmission? Or, the flipside of that can you make a bad transmission investment decision? This depends on how big your wallet is. If we have unlimited resources then it's difficult to make a bad investment. We do have limited resources so we need investments based a budget. It might be OK for Harvard to lose $1 billion in endowment, but if Austin Community College does that they're out of business.

Second, this interstate highway analogy is not useful. The interstate was conceived and built by a president who just freed the world from Nazism and defeated a number of powers who wanted to us harm. He had the ability to articulate a vision. There was a Cold. He could rally the troops behind a national policy. We don't have that now. It seems counterproductive to keep trying to get a national policy on transmission.

This issues are effectively addressed regionally. It's been done in ERCOT. SPP [Southwest Power Pool] is attempting to do this. Texas can build lots of transmission in ERCOT and address air quality, carbon, economic development, and fuel diversity in one fell swoop.

SPP is attempting to come up with some cost allocation principles, but it is a challenge to quantify benefits because it's not a market like PJM, or ERCOT. How should they put a plan in place which is probably going to ask for some degree of uplift at 345kV and higher?

Speaker 1: My favorite part of the opinion is having an articulable and plausible rationale for believing that the amount users pay is commensurate - not identical, not quantified - with the benefits they will receive. It's enough to say that we are a power pool, there's some

reason why these three states have joined together to join this power pool, and if everybody is going to be asked to pay a certain portion of it there has got to be a reason why you've decided on the allocations you've decided on. And if they can articulate what that is and show that they're at least commensurate, without doing a quantification, then they've satisfied the standard Seventh Circuit has asked for.

Question: So if PJM spent a little bit more time and energy on trying to calculate and articulate the benefits then the outcome might have been different?

Speaker 1: Yes. FERC tried to defend it on the basis of other policy reasons, not on a cost causation basis. That's why they lost. If they had spent time in the hearing, and in their decision making, an articulable and plausible explanation of how Illinois benefited, the case might have come out differently, if the benefits were truly there.

Session Two.
Shale Shock: The Revolution in Shale Gas Recovery, Electricity Markets, and the Green Agenda

Technological changes have enabled producers to extract abundant supplies of natural gas from shale. Almost overnight, available gas reserves have increased by an order of magnitude or more. The unanticipated abundance of natural gas supplies could alter the shape of the electricity market. How sustainable is the extraction of gas from shale? The injection of chemicals and the impact on water have led many environmentalists to raise objections to the practice. Are tough regulations likely to be imposed? Are they merited, and, if imposed, how will they affect the long term viability of shale gas supply? What will be the longer term consequences of the widespread availability of shale gas on future electricity capacity needs, resource mix, and profits? Will gas be the "fuel of choice" for new generation? Will gas generation be a substitute or a complement to renewable energy?

Speaker 1.

The Marcellus Shale Play. This is an amazing turnaround. As recently as March of 2008 regulatory authorities were arguing for increasing LNG facilities in major areas around the U.S. They were making a compelling case that supplies in natural gas in North America were dwindling, exports for Canada were declining, LNG was going to be the fuel of the future, the natural gas supply in North America was going to be fairly dependent on LNG, which would be the price setting thing. The need for an LNG facility could be easily made. Within a year and a halves time, the entire paradigm of North American gas has turned upside down. We have not recognized it yet and we don't yet know what to do about it.

I will focus on some of the issues in New York State which is facing a new model. There are opportunities here that we really need to think about as a nation. On July 3, 2008, the price of natural gas was $13.50. And the world has just absolutely changed in a year's time with prices around $5. New York is now a player in energy, domestic resources. They have a fairly substantial portion of the Marcellus shale infrastructure. There are tricky aspects for them, a big corner of the Marcellus Shale Play is right next to the watershed for New York City. Fortunately, it is throughout much of the rest of the state as well. There's a lot of legitimate concern that this new technology jeopardize the New York City watershed, and other New York State supplies?

New York uses about 1.1 trillion cubic feet a year. Most recent numbers show there's a 45 year supply in the State of New York. They're one small player in the shale development. They have 11 wells operating but none of them are the horizontal ones.

What are the long-term consequences of shale gas? First, nobody is expecting $13 gas again. Predictions are of $5 to $8 in the longer term. In New York State electricity prices are highly correlated to natural gas. It sets their marginal price 80% of the time and the other 20% is probably imports that are based often times on gas. It has an enormous effect on the relative economics in the state. Second, they're trying to do a renewable portfolio standard. Well, at $13 gas, they would have had a lot of wind development without having to offer anybody a penny to make it happen. With $5 gas it is a different set of economics. The same thing for demand response programs, and it certainly affects things like the economics of coal gasification, and new nuclear plants.

New York is already heavily dependent on gas. In 1997 they were about 45% gas and now it's 54% gas. They're not showing any need for new electricity until 2013, due to a combination of their energy efficiency and demand response programs, and the renewable portfolio standard. They don't have to add any base load generation in the near term. They expect a fuel mix around 53%, 54% gas, the rest being hydro, nuclear and a growing amount of wind and other renewables.

Will gas be the fuel of choice for new generation? It has been in New York for 15 years at least. Since 2000, 6,000 megawatts of new natural gas generation has been added, mostly near the New York City/Long Island area. Since 2000 they've added about 1,200 megawatts of wind. There's several thousand more in the works. The Marcellus Shale Play overlaps their wind facilities to some degree. So hopefully they can complement each other.

I expect the gas will be a compliment to renewable energy, not a substitute. It depends what you're doing renewable energy for, but one of the major reasons is carbon reduction. Gas cannot really substitute for renewables in carbon reduction. It is closer to coal than it is to wind in terms of its carbon output. It will compliment the intermittent renewables, if there is a larger portion. They've studied up to 3,000 megawatts of new renewables in the state and their other resources are sufficient to provide the balancing for wind and solar. Whether it's additional generation or energy storage to balance renewables, gas will be important.

As a side note, the nation is totally unprepared for widespread plug-in hybrid electric vehicles. People are just beginning to think about it while Chevy Volt is putting out the cars. When they start getting plugged into our houses I'm not sure what will happen, but that has nothing to do with today's discussion. [Laughter]

Critics of shale gas exist with some very legitimate concerns. It's a new technology, with legitimate questions. New York's Department of Environmental Conservation has been preparing a generic environmental impact statement. They believe they've got the toughest requirements in the nation for shale gas development. However, the developers are saying they can still work within this system.

For instance, one number that gets thrown around is 4.5 million gallons of water in the fracking process. That's a lot of water. Fortunately, New York is water rich so water resource isn't the problem, but water quality is extremely important. They want to make sure that this in no way hurts our water quality.

It is a regulatory challenge because it doesn't fit into the standard pipeline siting process. In pipeline siting there are folks on both sides that put it in with a guaranty that the day that pipeline is built that there are going to be users. Under fracking you've got to have that pipeline in place the day the gas explosion begins to get it into the system. It may not always be successful so you may occasionally have a gas pipeline from nowhere to nowhere. A very high percentage of wells that are fractured thus far have been highly successful, have met their expectations. The gas distribution systems, both the gathering system and the incremental pipelines have been worthwhile and met the need as they explained it. However, regulators are used to looking at need from a different perspective.

As a general rule, natural gas, being a commodity, will go where the market takes it.

This is true unless federal policy directs it elsewhere. We've heard for years about the need to get off our independence on foreign oil. In 30 something years we've done nothing to achieve that goal. So now this gift has been given to us of perhaps 50 to 100 years of natural gas. What are we going to do with it? Should the nation just let it function as a commodity, or do we try to take an affirmative action to do something with the gas that really changes our energy future?

For instance, what about using natural gas as a truck transportation fleet fuel? If we want to make that happen, just leaving it to the commodity market will not get the infrastructure in place. It would take a consorted effort at the federal policy level to create tax incentives for interstate truck stops to put in equipment, incentives for trucking lines to put in the infrastructure. Interstate trucking uses up to 50% of the petroleum in the transportation sector. A gas interstate trucking infrastructure could be easily implemented without having to affect every household vehicle. This kind of approach could reduce our imports of foreign oil by 50%, 80%, 100%. Given this windfall, we need to be careful to think about where it takes us, and if we want to have a national vision around it.

Obviously it could be used in residential space heating, industrial processes, transportation fuels, and plug-in hybrid electric vehicles. In the Northeast public hybrid electric vehicles charged from electricity are natural gas vehicles. It's the incremental fuel that is going to be providing the electricity. This takes the gas, burns it at anywhere from 30% to 50% efficiency, lose 5% to 10% more of the electricity in line losses getting to a house, and then plugging it into an inefficient battery in the vehicle. Hopefully this process gets more efficient as we go along, but it's fairly inefficient. It needs to be thought of as more than just an electric generation fuel, with all due respect the generators here. [Laughter] It's cleaner and more efficient than other fossil fuels. However, if we're going to do this it will take an infrastructure investment. For instance there's lots of lines in Ohio and Pennsylvania but less in New York, and even less in New England. Let's not throw our money at those transmission lines that we talked about this morning, let's invest in transportation facilities for gas.

The standard operating procedure for gas for the last 50 years has been to tap Gulf Coast and Alberta resources. This is really going to distribute it. Colorado, New York, Pennsylvania, Ohio, all have opportunities. I'm focusing on Marcellus in New York, but there are a lot of other deposits throughout the nation that offer tremendous opportunities to diversify our sources of natural gas supply.

Well production is based on a kind of an explosion and then a long sustainable period where 60% to 90% of the total gas is produced in the first year, and then after that a slower, longer, and more consistent flow. It's a different paradigm than an oil well with a 20 year supply pumping out on a fairly regular basis. It will be a challenge for drillers and marketers to figure out exactly the timing of all this.

We have to make sure that the environmental consequences of doing this are not going to hurt the ecosystem. It seems like it's very sustainable if we can do it cleanly. This is an opportunity that we need to think about from a policy perspective. It shouldn't just be thrown into the commodity mix and end up like previous gas bubbles. We need to think outside the traditional box of gas uses to take full advantage of this opportunity.

Question: Does the New York Commission have any jurisdiction over the drilling forecasts or oil in New York State?

Speaker 1: They have jurisdiction over the siting of the gathering and distribution lines. They do not have jurisdiction over the drilling. That falls entirely within the purview of The Department of Environmental Conservation.

Speaker 2.

I'm going to discuss this issue from the perspective of the gas producers. So, shale shock, how big is this change? It's huge. What is

driving this change is one major invention. They've been able to drill wells and frac them, but the big invention is the multi-frac horizontal well. In some cases, the industry is getting 10 to 20 times the productivity that they were able to get from a single well. It provides a huge benefit. They've known about the shales, but they didn't know how to get the gas out economically. So now there is an ocean of gas. How did the view of natural gas supply change so fast? How do we know this supply is real? What does it mean for natural gas prices? And what's the role of LNG? Let's look at all these issues.

The Barnett Shale is near Forth Worth, TX and it covers 10 counties; it's a very, very large area. Typically in an conventional exploration play, a developer would go out and find a very small field that might be one or two square miles in area, not 10 counties. Now this is an entirely different kind of way to extract gas than they're used to. Right now domestic producers are producing about 5.1 BCF [billion cubic feet] a day, around 8% of US production. They have about 11,600 wells.

The new approach is a light sand frac technology, which is basically water and sand. This is combined with horizontal drilling. So for instance, in the Barnett Shale it was predominantly a vertical play and they had about 4 TCF of reserves in 2002. Now that producer has gone to the horizontal drilling, and they have over 18 trillion cubic feet. They've almost quintupled their production capacity. Horizontal multi-frac technology has enabled this. The big turnover in technology came in 2003, when horizontal drilling technology took off. However, there have been ongoing efficiency improvements since then. That is why there's such a huge and rapid change.

There are shale gas basins all over North America. It is an absolutely enormous resource. They are continuous deposits, very much like coal, only obviously a lot cleaner. There is a very large area to extract this shale gas from, with lots of access choices. The breakeven price for a single well is under the $4 range for the Marcellus. The country uses about 21 TCF [trillion cubic feet] per year in the United States. In just the Marcellus Play alone, there's more than a 10 year or so supply for the United States. And that's just one shale basin.

One of the plays in Canada is the Horn River. It alone has 40 TCF, and possibly triple that. There is an ocean of natural gas out there that can be produced for substantially less than $8. We now can extract gas from shale, which we could not do economically before. There is now a 100 year supply of economic natural gas in the U.S. alone, a little over 2,000 TCF. About half of the domestic natural gas comes from these unconventional reservoirs now. Further, developers are not taking on substantial risk when they go after the current blanket resource formations.

In the 1800s drilling natural gas was a nuisance. It was found by very primitive means, creekology. They used primitive tools to find it like cable tool drilling which is more or less like dropping a rod into the ground and very slowly chipping away at the rock. Now they've moved into multi-frac horizontal technology which has substantially increased our supply of gas. They might drill horizontally for a mile or so and have 20 different stages of hydraulic fracturing going on all taking place 10,000 feet in the earth.

Another big innovation just coming out that will increase efficiency is pad drilling. In the old days they would drill a single vertical well and frac that. Now they take on a single area and drill about 10 wells or so from that one pad. From each well they might frac 15 times. It's possible to have 168 fracs happening in one small location. This substantially reduces the overall environmental impact; you're hardly disturbing the area at all. There's one small pad location for about every two square miles, as opposed to a high density of wells spread all over the place. They get a lot more gas and a lot less environmental disturbance. It is cheaper too. There is going to be a big effect from this. With the multi-stage horizontal fracs, they use imaging technology to see where the water and sand goes. This is to maximize the economic benefit of the well.

Let's consider LNG briefly. LNG will help keep the price down if the price environment goes up. It will certainly be in less demand in the shale locations and you'll see it buffering the price. I expect we'll see shale gas exports to Southeast Asia from Canada and the U.S. There is also an expectation of substantial capacity additions coming on stream. The emergence of shale developments across North America has accessed an ocean of gas that will keep prices low and is less than half the carbon of coal.

There also has been increased storage capacity which is important in buffering the price. I expect price volatility to dampen considerably, and a lid on high prices. It can provide lower prices, and cleaner energy, create jobs, and reduce dependence on foreign oil. It's a completely new paradigm in energy for the U.S. Those that are generating policy can have a huge influence on our economy, certainly on the poor. It can make a big difference.

Question: Alabama has a rather large field, but it's only accessible at about $8. However, it's a fairly populated area around Birmingham there. How big is a pad? I'm trying to visualize it. How much space does the water and the sand and other logistics take. How disruptive is it? I'm trying to visualize how this is going to work in a populated area.

Speaker 2: There are certainly issues in producing natural gas around urban areas. Chesapeake has done this quite a bit of this around Fort Worth. However, given the economics of shale gas, few are going to be interested in working in heavily populated areas because it will drive up the costs. There's not much of a need, but it's doable. Chesapeake has been innovative. I don't know how many acres their pads are, but they're relatively small. There is a lot of water and sand resource use though.

Question: You used the term hydraulic fracture stimulation. However the other speaker used the word explosion. [Laughter] Can you clarify this?

Speaker 2: Fracture stimulation was not used initially in the industry at all because they exploited reservoirs that had very high porosity and permeability. They'd put a well bore in there and it would flow a tremendous amount of natural gas. Those locations are gone. Now they go to poorer quality reservoirs such as shale. Hydraulic fracturing is used to increase the permeability of the reservoir, the ability for it to flow this gas. How does it happen? You take water and you pump it down into the formation and you crack open the rock. The problem is that once you let it back out, the cracks will just come back together and you'll lose your permeability. So somebody said let's put sand in there and hold these cracks open? It worked wonderfully. They've now been doing this for decades in the United States.

Speaker 1: In the way of clarification, explosion meant you got a large supply of gas very quickly, not that it went boom. [Laughter]

Question: Could you clarify on the fracture fluid? I try to get the producers to pay more attention to this. To them it's water and sand. The public concern is about that other less than 1% stuff that's in there. I understand that it's primarily soap-like substances, but when the industry ignores it, it creates more suspicion than addressing the problem. Is there some reason producers are not willing to explain what's in that?

Speaker 2: I'm glad that you asked that question. It is predominantly water and sand. If there is an additive beyond that it would be a tiny fraction, less than 0.5%. What is in that? Typically it is friction reducers, so a soap kind of a material. Those kinds of materials are found in common household products. There have been cases where people have put other things in there that you wouldn't want in your backyard swimming pool. For the most part, those things are not used today. For example people would put diesel in. For some types of fracturing operations they put a kind of gelatin-like material to help change the viscosity of the fluid, but those things are not harmful.

Speaker 3.

I'm going to address some of the environmental concerns that folks have had about this kind of technology. While we're focused on new shale production today, shale gas is a very mature industry. There are almost 500,000 natural gas wells producing in the United States today. That doesn't include old abandoned wells. It's a very high concentration, particularly in key areas.

I'm going to start with some arcane property concepts that are really important in thinking about how you get gas out of the ground. Let's look at the property law surrounding *split-estate*. In many places, you may own the surface of your land, but you may not own the oil or gas or other minerals that are underneath your land. If you don't own them somebody else does, and they can lease them without even telling you. This is an industrial activity, but unlike other industrial activities it happens in people's backyards all over the country. They are large operations with toxic chemicals and other risks involved.

There is another legal property concept called forced pooling, or mandatory pooling, or compulsory pooling that you may hear about, especially in the Marcellus. This means even if you do own the oil or gas under your property, if all your neighbors sign a contract you can be force-pooled with your neighbors to sell your minerals. You will get money from them, but you still cannot control what happens on your own property.

The third issue is eminent domain which is more of a pipeline issue but also comes into play we need the pipelines to transport the gas. There are folks who have had their property taken by eminent domain for pipelines and cannot use the property for anything else. Many of these people walk away from their homes and leave them to foreclosure. This is not an environmental issue but important to understand why we care so much about the risks that are involved here. In many cases, a drilling rig will be immediately adjacent to home. The laws are different in different places. In Texas, the standard law is 200 feet from a home. Some communities have instituted ordinances where it has to be up to 1,000 feet from a home. It is different in every state.

The risks of concern are toxic releases into the environment, air, water, soil, and destruction of wild areas and wildlife habitat. I'll discuss both urban drilling like in Fort Worth, and rural as well, such as New York or the Rocky Mountain Region. The contaminants have two primary sources. Some of them are naturally occurring. They may be in the gas itself or in the soil underground and are released during the process. Processes that are naturally occurring can be of concern. Second, chemical additives are used in the drilling, the fracking as you heard, and just the maintenance of the operations.

Air pollution is a significant concern. There are several components. Hazardous air pollutants is a list managed by the EPA of 88 air pollutants that are known to cause harm to human health. Some of these are in the natural gas itself. Depending on where you are, different things are in the natural gas when it comes out of the ground. Other air pollutants come from the engines or generators that run all the equipment, and also chemicals that may evaporate into the air at various parts of the process. Ozone is an issue. It's caused by a combination of volatile organic compounds, and NOx. In Western Wyoming, Sublette County has one traffic light. It's a rural county that used to have some of the most beautiful air in the world. Two years ago they violated the ozone standards several times. The ozone standard is 75 parts per million. Theirs went up to 120 something. Last year some of the drilling companies instituted new air control measures and they didn't violate standards. These are the kind of things that communities are dealing with.

Particulates are another air pollutant of concern. One can go to a house in Wyoming and see visible plumes and fumes from adjacent fracking operations, most often from diesel engines. Fracking operations involve hundreds of trucks, unless it's done by pipe. There are trucks going on rural roads that generally weren't built to have that kind of traffic.

There are also questions about emissions with no answers. There are pads with condensate tanks but no knowledge of the activities on that pad. Infrared cameras are being used a lot by Texas' Council on Environmental Quality. They show extensive levels of heat and emissions. There have been several studies in Texas just in the last few months, addressing air quality concerns that are coming up in communities. The Texas Health Department and the Texas CEQ are both involved in studies and monitoring.

Let's talk about a case in Texas in the Barnett Shale. One household immediately beside a drilling rig do not own their own minerals. A couple of months ago they were out and received a call from their neighbor saying that their fence had been bulldozed and their horses were running down the street. This was the first they heard that their property was being taken by a drilling company. They owned 10 acres and five acres were taken for the pad. Generally, the drilling pad is five acres. After the drilling they usually keep about two acres for the big shale wells. That's a rough estimate. While this is not an environmental issue, there are serious concerns about how residents are being treated by some of the well developers. There are other stories, and video on YouTube, of drill cuttings being overshot onto families land.

There are also concerns for greenhouse gas emissions. Natural gas is cleaner burning than coal, but there are extensive greenhouse gas emissions on the upstream side, which is the production end. Some of these are leaks. Some of it is intentional venting, say, for example, when the well is being drilled but before it is hooked up to the pipeline. Also known as flaring. There is also the equipment that's being used to run the operations. There have been issues where water is on fire in Colorado, literally in a residential sink, because there's methane in the water. It's not conclusive whether the methane came from recent drilling or whether it was something there in the past. Methane been found in water in Ohio, in Pennsylvania, and other places that wasn't there before. Research has shown migration between natural gas wells and drinking water sources. The burning water is just a great visual. It also demonstrates the overlap between methane as an air pollutant, and the concerns for ground water that I'll address next.

Ground water. Once we get past air there are a couple of types of water contamination. One is ground water. Ground water has been contaminated through drilling, fracking. Again, this can be naturally occurring substances or toxic additives. The other issue related to ground water are the large pits that are built on pads to contain some of the waste during the process. There are water contamination incidents in many places. There is one town in Pennsylvania with 15 families that are suing their drilling company for contaminated water. This is happening in many states. There is drilling in approximately 30 states right now. A lot of these water contamination incidents seem to occur after a nearby fracking operation. There is no documented conclusive proof that it is caused by the fracking. The largest concern is mostly that state regulators have not been investigating this in a way that would provide conclusive proof. Environmental groups are asking for federal regulation of hydraulic fracturing.

The EPA is currently investigating homes in Pavilion Wyoming. They have found chemicals in the water of people's homes that are the same as those used in the fracking process. There are homeowners there whose water filters are black after 3 days of filtration. It is extensive contamination. Retention pits are another source of concern – surface water contamination. There have been documented leaks in Colorado. These leaks have the capacity to extend into streams and rivers. There's concerns about both aquatic habitat, as well as potential drinking water sources.

Toxic waste is another issue. The industry creates tens of billions per year. A lot of the waste is the used fracking fluids, but there are other types of waste also. These are handled in different ways in different places. Some are large open air pits. Some states have different requirements for lining these pits than others or what you do afterwards with the materials. A land farm is generally acreage where solid waste drill cuttings, which as I said comes up after the

drilling is done, are spread on the ground and there is a bio-remediation process. Pits and drill rigs can often be within a few hundred yards of a house. In the Rocky Mountain Region because the air is so dry it is evaporated via misters to get rid of the waste quicker. Dust can be an issue as well, because it can include toxins.

The bottom line is that there are health impacts for people around the country. There are livestock issues also, especially reproductive issues in terms of fertility, milking and things like that. This is anecdotal evidence, but there are a lot of people are reporting them. So far there is no strong peer-reviewed solid academic research. Tied into all this is that there are extensive exemptions from various federal environmental laws for the industry.

There is some good news. There is a lot of technology available that companies use. Some companies are doing some good things in some places. All companies should do lots of good things whenever they can. They can use nontoxic substitutes. They can recycle water and reuse it instead of taking fresh water. And they can clean and treat the water. They can use pitless drilling. They can cluster the wells. Up to 40 wells are being permitted close proximity in some areas now. The piping systems are really interesting. With fracking there can be hundreds of truck trips a day. With a piping system and centralized fracking facilities the truck traffic is not necessary. Capture of air emissions can be implemented. Wells can be built to a higher standard. This can be a win-win because many of these techniques have been shown to actually save money for companies when they are cleaner, they're more efficient. They do not have risk of lawsuits.

For instance, capturing the air emissions. Part of what they're capturing is methane. They make money when they capture the methane, but they're also capturing some of the hazardous air pollutants. Pitless drilling has been shown to save money, and so has recycling drilling and reusing drilling fluids, etc. In Colorado Williams eliminated over 25,000 truck trips by centralizing their fracking operations. It reduced impact on the habitat, saved them money, reduced the impact on residents in the area.

With the big national picture, the nation's priorities need to be efficiency and renewables. There are some places where natural gas production should not take place, and that includes the New York City Watershed, parts of the Rocky Mountain Region, and immediately close to people's homes. In the other places the standards could be a lot higher than they are. We need new regulations if companies are not going to do those things voluntarily. However, the technology is out there and there are win-win solutions that are better for companies, better for communities, better for the environment, and still allows the gas to be provided to the market. If there is going to be a new explosion in natural gas, it's going to be a lot easier to accomplish that if communities are comfortable and happy with what's going on in their backyards.

Speaker 1: What is the process for determining where to put the pad? Does the drilling company have any right of eminent domain or is it just a negotiation with the landowner or the landowners in the pool?

Speaker 3: It's complicated. If you're the landowner but you're not the mineral owner you don't have any say, unless there is a rule that says it has to be at least 200 feet from your house. There are examples where a company has a lease of several hundred acres but they put the rig right next to a home. It probably is a combination of geology where roads are, where pipelines are, but that seems less responsible.

Speaker 2: In general, it's a negotiation. You do what makes commonsense. If the landowner has the mineral rights you would just be amazed at how interested they are in developing those resources most of the time. That's certainly easy to understand.

Speaker 1: But, if I own the surface but not the minerals, can you put a pad on my surface without my permission?

Speaker 2: It depends on many different factors, but in some cases yes and in some cases no.

Speaker 4.

Let's consider the future of gas. In August of '09, a Barclays report acknowledged a short term game for gas, though with long term skepticism. There has been a lot of switching from coal to natural gas in the past year. Power consumption is down about 4%, coal usage in power is down about 13%, gas is up about 6%. The Barclay's analyst argued that it is because of unsustainably low gas prices. However, others in the industry clearly disagree, particularly with the shale plays. The Barclays analysts said that a combination of the existing state RPS standards, the impact of the stimulus package on renewable development, combined with more muted demand for electricity going forward actually means that gas does not end up creating long-term fuel switching, and may actually reduce over time.

We've had real problems when experts have said, here is the new miracle fuel. So now we're awash in ethanol but now it's a growing disaster. We've never had one fuel that can save the country, whether it's ethanol, coal, nuclear, gas, or renewables.

In the build out of the last decade the country has added 250,000 megawatts of electricity that was gas fired. The key impact on the electricity markets is the marginal price in the RTOs, which has been natural gas. Basically everywhere but the west of PJM and in SPP, gas is on the margin. It fundamentally impacts the economics of this business, the revenue stream, market price signals, etc. Citigroup has done some analysis. Power prices in 2008 were in the $75 per megawatt hour range when gas was $6.50 to $10. When gas is now $3 to $5 instead of $6 to $10 the wholesale prices dropped from $75 to $36. It's basically been cut in half. With gas prices around $5 to $7, that puts power prices to still less than $50.

With gas prices much lower, it starts to call into question the more expensive options that are being invested in today. For instance, it can make a new base load coal plant begin to look very expensive. Further, the other major issue is carbon.

Carbon policy is going to be complicated. There was a view at one point that it would be easy. We're going to get a price on carbon. That's going to make the price of coal more expensive relative to gas. Gas will win. They'll be switching to gas. In fact, what has happened is that the combination of free allocations and wide use of offsets in Waxman-Markey and senate bills, along with a 2025, 2030 timeframe, changes everything. The gas folks are upset about this and are looking to pursue their interests as these bills continue to get crafted. Many of the things that gas producers want would advantage new gas generation being built.

Will gas actually be more advantageous compared to the other fuels in a carbon constrained world? EPRI's MERGE analysis has two bookends. If you don't get much CCS for coal and not much new nuclear it increases gas a lot. We cannot meet the Waxman-Markey 2030 targets of a 43% reduction in our CO2 compared to 2005 unless there are a lot more carbon-free fuels, not just 50%. How gas fits into the carbon debate is a big piece of this. It is important because, for example, gas right now does not get to participate under the legislation in many of the CCS carbon capture programs, whereas coal does. So merely having more gas and having it be cheaper doesn't automatically translate into it being used. Further, our past attempts to predict prices or pick fuels have failed. It is imperative that we let the market determine the success of gas. More than likely we're going to have more, but the market should decide how much. What we need is a regime where we put a price on carbon, get the market signals right, and let everybody have it compete to meet those policy goals.

Question: I'm curious as to where you got the statistics about gas setting price in PJM almost 80% of the time, because the market monitor and their own analyses have shown that gas only sets price in PJM about 25% of the time.

Speaker 4: It's in the Barclays report. There's a debate in the context of the Waxman-Markey bill to give a separate small set aside of allocations to merchant coal, and a debate about when does gas set the margin. Apparently, the

difference comes down to whether one weights the hours by the amount of power generated during each hours. If you base it strictly on the hours of the day you count, 3:00 in the morning being the same as 5:00 in the afternoon, you'll get one answer. Measured that way, 70% of the time coal sets the margin. The Barclays analysis weights each hour by the amount it is off-peak or on-peak. This produces results that show a stronger effect for gas.

Commenter 1: It's actually easy to see what drill pads look like from Google's satellite view. For instance you can look at Rangely, Colorado. It's in Northwestern Colorado. One can see around the town these white dots. Those are all drill pads located in the neighborhood of Rangely. This is mostly unconventional gas, not shale gas but the pads look similar. There is high density and it has become a major issue in Colorado. Their governor, and their Oil and Gas Conservation Commission have done a lot of work on rules, and environmental protections.

The pads are often 200 meters apart through the valley. It is extensive impact they are attempting to manage. There is a road to every one of them, and all within spitting distance of a town. Often these locations are in wildlife areas and national forests.

Question: How big is Rangely?

Commenter 1: Rangely is probably 5,000 people. Colorado has, in total, 31,000 gas wells. There are around 50 of them near Rangely. These installations are very large complicated political, environmental, energy, and economic development issues to work out. Colorado was ranked two years ago, as the number one drilling location in the United States. The Oil and Gas Commission there adopted a set of rules which, according to the industry, were oppressive. They went from 1st to 46th in the United States, in terms of friendliness to the natural gas industry. Everybody has calmed down now and things are moving forward there. This is what New York will face. Colorado is number six in the country for natural gas production. They have some shale but nothing like some of the other shale plays. The tight sands gas and coal seam gas, which is much of what Colorado has, is relatively higher cost. As the shale boom continues, they will drop in rank.

Question: The environmental issues have also been big in Pennsylvania. What would the most stringent environmental rules do to the price of gas? What kind of impact would you estimate that it would have in Henry Hub dollar prices? Second, with all this gas production projected to come from the Marcellus shale areas, who is going to build the pipeline capacity to bring the gas to the infrastructure in place today? Will this pipeline capacity be similar to other bottled up gas like the Rockies Express Pipeline that is bringing production from Wyoming and Colorado to the east? This has really opened up the gas markets and dampened prices. In that case it's been the producers that have paid for the pipeline capacity rather than the shippers and the LDCs that had done so.

Speaker 3: Let me start with environmental issues. There are exemptions in federal laws like the Clean Air Act, Clean Water Act, Safe Drinking Water Act, and that exempt oil and gas production. Environmental groups want those loopholes to be closed. That's the starting point, but they don't think that's going to add to the prices. It's clear the technologies are there. They're proven. Companies are using them in many places, they're just not using them every place. In many places they are proven to be quite economic or even financially beneficial for companies. Minimal regulations and enforcement as I've described should not impact the price. There are places where state and local government should be doing more, too. It's all very doable.

Speaker 1: Some of the pictures we've seen of hydraulic fracturing that showed a cloud of pollution was actually foreign oil being burned, diesel I expect. If those trucks burned clean burning natural gas we wouldn't have that particular problem. [Laughter]

Speaker 3: Or if the equipment was run by solar panels.

Speaker 1: I suspect the industry could get some help from the environmental groups to address these issues, improve communication, and ensure things are done properly. For example, on the fracking chemical issue the Department of Energy has a list of the types of chemicals that are used in fracking. They are benign chemicals that are used at this point forward. Decades ago, who knows what people did, but at this point forward they are benign chemicals that are used in makeup and cosmetics. It would be smart of the industry to reach out and address these issues preemptively and proactively, rather than do something that ends up causing the natural gas price to come up.

Speaker 3: There are agreements between the environmental community and most of the industry on some things. I think they disagree on how dangerous the fracking chemicals are. I recently saw a presentation about a community in Western Colorado that had a voluntary agreement with one of the drilling companies called Antero. Antero agreed to do a whole number of things. One of them was to use green frac fluids, for example. Another was to use pitless drilling. That agreement was reached a couple years ago. Antero estimates that it has reduced their profits slightly, but they are still drilling and producing. It hasn't stopped them from thinking that it's a good business decision. One of the reasons they did it was because companies do face litigation in a lot of these communities. It's a financial risk. There's a real benefit, and it is worth doing on a voluntary basis.

Speaker 1: Let me address who will build the pipelines. Natural gas really is a very mature commodity market. The open season system has worked successfully. There are several projects that want to serve the New York City load trying to figure out ways to get into New York City from a variety of different directions. If that model continues, it'll meet some incremental heating load, maybe the occasionally industrial customer and the big generation facility that needs to get build, and we'll use up the resource. If we want to change the way we're using the gas then a new infrastructure will be required, with regulatory incentives. For example, if you wanted a natural gas trucking fleet, you would need additional actions and federal policy. It could be in a market matter through tax credits, it doesn't necessarily have to be a command and control approach. The already mature system will get to where it needs to go if they can find both the buyer and the seller to use up the gas. Getting gas pipelines sited has been more of a localized environmental issue rather than a big problem with the infrastructure. It's not as hard as electric transmission lines.

Speaker 4: Yes, the infrastructure is not the issue. Actually, one issue is having more gas closer to load which will reduce the delivery price to New England and New York.

Question: It's going to be the shippers and LDCs that are still going to be the ones that are driving the need for this rather than the producers?

Speaker 1: Sure. But if the shippers have some nice new cheap supplies they will figure out a way to get it into the market.

Question: The increase in shale production in the United States has had a big impact on the demand for LNG in the United States. This has rippled through the LNG market in the Middle East where their prices are also down. There is a concern in Qatar about oversupply and they have all these big projects that are coming online. Many of the companies are in the middle east, in Canada, in Egypt, so there is an international involvement in the gas market.

My understanding is that there is a lot of shale deposits in Germany, Poland, Ukraine, China, and India, all kinds of places which are on the wrong end of the pipeline from Putin's perspective. [Laughter] Aside from economics, these might be developed for strategic reasons, to offset the power of the Russians and others. That will dramatically affect the natural gas market and the LNG market, which is now an international story. It seems that this would put a strong cap on the price of gas for a very long time. Is that accurate?

Speaker 2: I think that is absolutely correct. The horizontal multi-frac well is so effective and its penetration is still so minimal. When this starts happening, when people around the world become aware of the technology, prices will be held in check. One thing that is interesting about LNG, if we had one world government, which I hope we do not. [Laughter] But, if we did, we would produce LNG probably from one field only, which is the world's largest field near Iran. This is because the money that is generated from the liquids production there is pretty much enough to pay for the operation, which means the cost of LNG is almost zero because they've stripped value from the liquids. As Iran ramps up production of LNG, that provides a serious issue for producers in North America because the thought of nearly free LNG coming to our shores is pretty intimidating.

Speaker 1: It doesn't sound so bad from a regulatory perspective. [Laughter]

Question: I want to make a point about the organized markets. Part of how this technology developed was because the price went high enough that the producers took a chance and went out and tried new things. When electric markets keep stopping the price from roaming where it might go, that kind of potential happy accident is less likely to occur. What is the implication for rate basing multi-billion dollar clean coal technology, etc. Should that go back in the R&D labs and wait until it makes economic sense? Is the government trying to pick a winner?

Speaker 2: Natural gas is a fuel that is much more amenable to carbon capture and storage. It's a much simpler problem to inject carbon from nature gas burning. If the market is allowed to have a say in it that's where it will happen.

Question: Could you elaborate on that? Why is it so hard?

Speaker 2: Well, it's a simple, if you burn pure methane you have only carbon and hydrogen, and so the byproducts are simpler to separate into CO2. Further, it has slightly less than half the carbon. So if carbon is an issue that people are concerned about then that's the obvious solution.

Speaker 4: This issue is starting to come up. AMP-Ohio, which is the aggregator for a lot of municipals, recently cancelled a fully permitted coal plant. Now, it was largely on the economics with the price going up but included opposition in the environmental community. The same thing happened at the Cliffside Plant for Duke in North Carolina. Now, in the Duke case, they went ahead and they're building the plant. Part of the opposition from the environmental community was based on the notion that if they went to market, there was enough unused gas capacity in that region, that the plant would not be necessary. Progress is closing 11 existing coal plants to switch to gas. This is having an impact. Areas are thinking that if they can stay with gas, they can avoid a lot of expensive plants.

Question: There are people who are saying let's stay diversified on fuel so any surprises never hit too hard.

Speaker 1: Yes, there are a lot of unanswered questions. This is a new technology. It's a new invention. I'm very optimistic about this new invention, but there are some really difficult questions that need to be answered. We don't want to learn the hard way. Pennsylvania needs to determine if there are some serious water problems. Other states need to move forward carefully.

Second, if we're truly serious about 80 by 50 carbon reduction, we cannot eliminate any technology. Every technology will be needed to get there. This can help bridge our way through the next 20 years here. From a carbon perspective I would argue that using natural gas in transportation may be the best use of it. We can use renewables to power our electricity system to some degree, but it's tough to take a renewable directly into a vehicle yet.

Speaker 2: The multi-frac well that goes a mile long horizontally is a new invention. What is not new is hydraulic fracturing. The environmental issues of putting high pressure water and sand

and other chemicals in the ground is not new at all. The industry is familiar with that and how to take care of those issues.

The other issues also involve liners that are not a foot thick or an inch thick, they are 2 miles thick. Fracking happens well down in the earth.

Finally, there are problem players in the industry. There are people that go out there and do the wrong thing. So hopefully the industry and environmentalists can work together to be pro-active about addressing concerns.

Question: I'm interested in the price of this cheap gas. The IEA reports for Europe gas prices are between $9 and $11 on average for gas from shale. The EIA prices are between $6 and $8. Your figures are between $3.50 and $7.50 gas. If we consider gas north of $6, LNG can come in easily below that. Can we hear more about the price differentials, and how the market for shale gas compares to LNG prices?

Speaker 2: Yes, LNG will put a cap on the price of shale gas, and I can't tell you more about prices – it's hard to know exactly. However I think we will continue to see efficiency gains and innovation in this area. The industry is going to get better at this. Apache has a new patent for a technique with pad drilling that creates a fracture stimulation manifold. It will enable 24/7 fracking operations which will absolutely drive the cost of fracture operations down if it works. Other companies are also pursuing new innovations.

Question: So the technology and, therefore, the supply of this is going to be moving towards the cheaper part of the range that I gave you over time.

Speaker 2: I don't know what the number is. Six dollars seems like a reasonable number. I don't know what that number actually is.

Question: There's another factor at play, though. We're comparing LNG prices versus our domestic natural gas prices and the clearing price. However, LNG is really competing against oil prices. In the old days gas and oil prices used to track pretty good. That ended a couple of years ago as well. If oil is a $10 equivalent and gas is $7 here in the United States, they're not going to bother coming to the United States and selling at $6.80 when they can sell at $9.50 in the rest of the world. The LNG will continue to flow to those other nations. Even if LNG may be cheaper than natural gas here, there's probably other markets that they can do better.

Question: That's probably true of the Pacific market. It's probably less true of the Atlantic market.

Speaker 4: What I've been hearing is that production levels have stayed high, despite high inventories in storage at a much lower price. It seems that it may not be necessary to get as high a price as the industry thought even as recently a year ago for the production to continue.

Comment: In the past couple of years, as this invention has been refined each well suddenly is much more productive than it was the year before.

Question: A new abundance of gas works as a compliment or a competitor of renewables? One argument is that because of the intermittent nature of wind, for example, gas could fill in the downtimes of the turbines. But, on the other hand, given the distances in transmission and the ability to move gas, gas is more flexible because you could use either wires or pipes. Is it really a compliment or a competitor? What does that do if we are to adopt natural RPS?

Second, if prices are so low, how will that affect the independent power producers?

Speaker 1: As far as the compliment versus competitor, I think it's not one or the other. Lower prices do mean more of a subsidy required to get renewables online compared to conventional fuel costs. However, the total cost of creating supply with a combination of wind and natural gas actually can bring the total cost of that future down. It's a bit of both. I'm not sure how to balance those two.

Speaker 4: I've heard the argument that the RPS helps because then gas is a backup to the intermittents. If the Barclays analysis is correct and the RPS standard is actually met by power as opposed to paying the penalty then renewables compete against gas generation. Some gas producers say let's not have an RPS, let's have a clean energy standard which then would allow the gas to be included. Gas groups are leery of the RPS.

Second, very low gas prices lower the profitably of gas producers to some degree, for a variety of reasons. However, although some companies are all one fuel or another, companies are fairly diverse. As a sector IPPs are doing everything: nuclear, wind, gas. Finally, the IPPs are hedging and using derivatives to cover volatility, and that means they are doing a bit better than people assume. That's one of the key reasons why the sector has not been as impacted by the drop in the gas price and the drop in the sparks spread as would have been the case without the hedging. If they take the derivatives tool away then the impact would be greater if gas prices stay lower. Congress is literally debating this as we sit here.

Moderator: Great. Thank you. Commissioner Parker?

Question: The EPA and the new regulation on greenhouse gases just came in. How will that affect gas? With this being a new EPA, what about any regulations on this industry that might make a change in the environmental impacts and the environmental regulations?

Speaker 3: Congress recently directed the EPA to do research on hydraulic fracturing in the Interior and Environment Appropriations Bill. I expect they'll do a major study on that issue and the potential risks to groundwater. EPA has also agreed to look at their oil and gas air rules. The loophole in the Clean Air Act that I mentioned before needs to be statutorily changed by Congress, but there are a lot of other things that EPA can be doing.

Speaker 4: They've proposed rules for the transportation sector, which comes out of the recent Supreme Court Case. There is a set of toolkits that basically revolves around EPA defining what is the best available control technology for each type of power plant. Once we know what that is then we can figure out the impact, but it's still an unknown. Some say the EPA action on carbon will prod Congress into action on the legislation. Alternately, they may have to limit what they do. The law actually says they have to regulate down to 250 tons, which is not much. If they go to 250 tons that's every source in the country translated into every voter, every small business owner. It's not clear how they would approach that politically.

Question: Is the availability of an ample lower carbon fuel changing the debate in the Congress about what to do about greenhouse gases. Particularly if it's a fuel that will create jobs in places where coal mining might lose jobs?

Speaker 3: There is discussion around the Senate Climate Bill of whether there should be additional provisions related to natural gas.

Speaker 4: This is a bone of contention between the gas producing community and the house democratic leadership that fashioned the legislation. They didn't know about all this shale gas when they crafted Waxman-Markey. The gas producers now want their piece included in the picture. They've launched a $50 to $80 million ad campaign.

The combination of the availability of the offsets, which is quite large and has expanded on the floor for the farming community, and the free allocation of allowances that will to coal utilities has really fueled their concerns. They want either a bridge fuel credit which would bust the cap, international offsets, or allowances from somebody else, or taxpayer money for companies that have coal plants to repower, which would then put them in competition with IPPS, or they want to change the RPS. There's some bad blood between the house democrats and the gas producing community over whether the house adequately took it into account.

Comment: It was July 3, 2008 when gas was $13.50. Washington still doesn't understand the new environment for shale production. The

regulators are just beginning to catch up. they'll have to address it as they go along.

Speaker 4: There's now a natural gas caucus started. To their credit, they've organized, they've got good materials, they've got a good organization and they're up there more publicly.

Question: We've heard the productivity of the wells has increased dramatically. However, I've heard that the decline rates are incredible. The first couple of years it was way up here and then it's down and stays pretty flat. Has that changed or is that still accurate?

Speaker 2: Well, that's very basin dependent. Haynesville has some of the steepest declines of any shale gas play, and that's because of the geology, and a number of different factors. It depends on the basin. A conventional reservoir has a very different profile. You'll have much less decline for a number of years, and then often times it will just end quite abruptly. The difference with shale gas is that, as you mentioned, once it gets on stream you have a number of wells. And once you get beyond the initial flush of production you'll have a great deal of gas coming for decades from that well.

Question: Let's think about portfolio theory a little bit. While areas want a broad portfolio there are issues with other resources. Nuclear is a problem because of storage and financing. CCS for coal has technology and scale challenges. There are challenges as to who owns the CO2 once in the ground and litigation risk associated with that. With wind and sun, they're intermittent, we need storage at scale. One could hypothesize a future scenario where it's renewables and gas. If so, don't we need to do everything we can to drill everywhere we can, as often as we can so that supply is there to keep the price down?

Speaker 4: Well, there are questions out there about various issues. How many nuclear plants would you have to build to get to the targets that are in Waxman-Markey?

Question: 75.

Speaker 4: We need 120,000 megawatts of zero emission electricity added to the system in order to get the Waxman-Markey target in 2030. We're more likely to end up in the gas and renewables end zone.

Speaker 1: My hesitation is using this just on the electricity sector. And if plug-in hybrid electric vehicles really take off and we start to see significant new electricity load being required, we're going to be building under that scenario the renewable gas combination in order to meet that. We need to consider the transportation objective.

Speaker 1: One has to worry about putting the eggs in one basket. We don't know if this approach is truly sustainable.

Speaker 2: Well, we've been producing gas from shales for quite a long time in some areas around the Appalachian Mountains, etc. Producers are putting their money where their mouth is.

Speaker 3: This is still a finite fossil fuel. Even if that's the best case scenario, it's only 100 years and it probably isn't 100 years worth. It's not really the fastest, cheapest, easiest way to achieve a cleaner energy future and renewables. Jimmy Carter was made fun of for wearing his cardigan. If we had built every home as an Energy Star home with solar generation since the late '70s, we'd be in a very different place now. When we rely on something that's a finite fuel, we don't do everything we need to put in place what really is the long-term solution. Gas is really important and it is a bridge. How long a bridge, how wide a bridge, how strong a bridge, are the questions.

Question: If we switched every kilowatt hour of coal produced electricity today to gas produced we'd cut US electric sector emissions of CO2 by 40%. It's great, but that's not even the 20/30 goals in Waxman-Markey. This cannot be the answer forever. We have to add CCS to that if we're going to rely on gas for that length of time. If you don't capture and sequester the CO2, gas gets you only to a point.
Will we see more physical hedging, essentially longer term contracts with utilities to dampen

those price volatility swings? Long-term contracts in the gas business have not been used in quite a while, but with the CTFC regulation, a market clearing requirement for hedges, it seems to me those will be less accessible, more expensive. We want long term contracts, but they're even tougher to get now. Five and ten year contracts for natural gas, would solve a number of problems. It would allow regulators to get more comfortable with committing to gas as a base load fuel, it moves gas for producers who got shut in gas at $3.50, it would move gas at $5 or whatever the contract price would be. Is there anything government can do to sort of induce that behavior and allow more hedging?

Speaker 4: There is an interest with the producing community to pursue this. Utility commissions have tended to allow utilities to purchase long-term coal contracts but have been less supportive of gas contracts because the gas price keeps moving and there is concerns for prudency. There is interest on both sides however. IPPs have successfully used hedging to stave off volatility, it's a valuable approach. Most are in agreement that we need to find a way to keep hedging in the mix while stopping the kind of AIG behavior that got us all in this mess.

Question: What happens if a Commission agrees to lock in a ten year $6 contract and it turns out gas stays at $1.38. Then new commissioners come in and try to blow that deal up.

Comment: Having gone through that myself as a regulator, the biggest problem was the sort of herd instinct, that everybody moved in the same direction at the same time and there wasn't a portfolio sort of approach. Regulators need to develop a portfolio approach to longer range contracts, staggering and avoiding the herd instinct. If they maintain a reasonable portfolio it should work fine.

Question: I would submit that we are in a better position today to lock in long-term contracts than the past simply because they have a better idea of how much it costs in one particular area. Forecasting is so much easier. The technology gives the industry much better information on the actual deposits in an area.

Question: I'm curious about the price variability over the various shale plays. There's quite a range in price depending on the different shale deposits. Is that price variability purely geological or does it also have to do with jurisdictions?

Speaker 2: It's a variety of factors. It's geology. How deep is it? How thick is the particular deposit? It's also where it's located. Is it near a market?

Question: So access issues.

Speaker 2: Absolutely.

Question: Right. But not necessarily the environmental laws of one given state versus another given state?

Speaker 2: Oh, those can factor into the price as well. No doubt about it.

Question: What do you see as the chances for ANGA and the gas industry moving to create preemptive industry best practices that might address some of the environmental concerns from environmentalists?

Speaker 3: That's a good question. We've seen that in other industries, but I haven't heard anything about industry efforts to do that. It's a great idea. There is a group in Houston called the Houston Advanced Research Center, and they have a project called the Environmentally Friendly Drilling Scorecard they're putting together. There are industry folks on it. Their idea is to create a system, very much like the LEED system where there's a list of best management practices. You get certain points, and depending on your total points, a developer is rated silver, gold, platinum, whatever. That's their goal. They've gotten federal funding to create that. It's a couple years out. The Houston group is trying to be an independent broker. I haven't heard of any efforts that are just generated by industry, but that kind of effort would be very helpful. A real effort would

probably be much easier than getting new laws implemented by Congress. Well, maybe not. [Laughter] But could be.

Question: We've seen this gold rush in different technologies before, and it tends to bring out cowboys in the early stage to try to beat everybody else. It hurt the wind community because some developers did sloppy things that hurt the whole industry. I would strongly encourage the responsible players in the industry to voluntarily get there without the damage being done by the bad guys, because that doesn't help anybody.

Speaker 3: One issue is that there is a lot of contracting and subcontracting. So, for example, in Dimock Pennsylvania Cabot is the operator. My understanding is typically they hire one company to drill the well, they hire a different company to frac the well, in this case Halliburton. The regulators often hold the operator responsible because they hold the permits. There is a whole web of who is actually doing the work and who is responsible. Lawyers have a ball figuring out who they can sue. It's fairly complicated in that sense, too. And you have to have the right people at the table, because there are a lot of different players.

Question: There are land rights horror stories in wind. Developers would rush in and try to find the dumbest farmer, in a sense, and pay him the least. Then finally the community would start to get together and realize how variable the payments were, how some people, frankly, were getting a little ripped off. It made the whole wind industry look bad. The same dynamic could happen with shale gas.

Session Three.
Electric Storage: Building the Market

Electricity storage is a tantalizing technology for the electricity system. Whether it is electric hybrid automobiles, enhanced batteries, or other technology, policy makers are thinking about how to incorporate storage technologies into the structure of the marketplace. How, for example, should batteries be treated: as transmission or generation? Is there any downside to allowing it to provide ancillary services? Can storage be treated as a portion of a renewable technology, especially if it is positioned to valley fill for wind generation when the wind is down? What incentives, if any, should be provided to encourage more storage capacity, or, is the technology sufficiently developed that it can stand on its own economically? Are there particular types of technology which merit more favorable treatment than others? How should storage facilities be paid for: by system charges (e.g. transmission), on the same basis as generators, or in some other fashion?

Moderator: It's clear that small scale battery storage, for example, for cell phones and laptops has an obvious value that far exceeds its cost. When we move to grid-based applications it's less clear. If we look at lead acid batteries, a back of the envelope calculation says it costs about $50 per megawatt hour stored. It's hard to argue on the basis of economic benefits that a $50 per megawatt hour storage makes any sense for peak shaving and valley filling. One can include reliability benefits but, as the discussion yesterday indicated, we have a hard time evaluating those benefits. Nonetheless, there are significant potential reliability benefits. So what is the right way to achieve it? There is an experiment to use a sodium sulfur battery to improve reliability in a town in Texas. The money they were planning to spend on that battery would have provided a 5 kilowatt backup generator for every household in the town, plus $5 million in change to buy some gas. It does not make sense economically.

The thorniest issue here is the regulatory issue of an asset that has both generation and transmission characteristics. It is very tricky when you have an asset that has both types of

characteristics to figure out how to appropriately regulate it or expose it to market prices or both.

There are other electrochemical technologies and other storage technologies more generally that provide potential for a lot lower cost. We'll look at costs estimates, and other value streams in all of this.

Speaker 1.

I am going to set the stage of what has been done, what are the applications, what are the technologies. Storage provides energy when it is needed, just as transmission provides energy where it is needed. They are really counterparts of each other. Transmission is widely developed and storage not so widely developed. The US electric grid is certainly a technological marvel but as it becomes more complex, it's also a reliability threat. Any unbuffered stressed complex system is inherently vulnerable to collapse and the US grid is unbuffered and complex.

Storage, in fact, is already on the grid, about 2.5% of capacity. It's all pumped hydro basically. In Europe it's 10%. In Japan it's 15%. The more you buffer the more you can respond to outages and other complications. There are a whole universe of possible solutions that vary by power rating and discharge time. There are the mature technologies of pumped hydro and compressed air energy storage. There are flow batteries, the lead acid battery, the sodium sulfur battery, metal-air batteries, and then flywheels as well.

Reliability and power quality which has become an absolute necessity for the digital society. Studies show that the estimated cost of outages is about $80 billion annually. That's real money. It is one-third the total electricity budget. Interestingly enough, two-thirds of that are short outages, momentary interruptions. These are a fertile field for energy storage because you cannot bring a genset on in less than 15 seconds but with storage you can do it seamlessly. There is technology that's cost-effective. For instance, a 10 megawatt system can cover 30 seconds at a microchip plant, after that the genset takes over. A 40-megawatt plant in Fairbanks, Alaska paid for itself in three and a half years. It's at the end of a very long line and they have a lot of outages out there so they have this humongous plant. The size of these storage units is beginning to become bigger and bigger.

The next area, voltage and frequency regulation is essentially market ready. Here the load goes up during the day, but load and generations are always slightly out of sync so you get this flutter which is resolved by changing the frequency. Every now and then you have to zero this out. They do this by the ISO sending out the signal and participating fossil fuel generators go a little bit up, a little bit down as the case might be. It's not a very efficient way of doing it because when you jerk the plant around that's when you get more pollution than on the average. Instead these can be addressed with fast storage, and the fast storage doesn't just take several minutes to kick in, it happens immediately. The California Energy Commission, and NYSERDA have had the first trial of a fast storage facility. It is a 100 kilowatt 15 minute flywheel system which worked very well.

Fast storage may be twice as effective as using gas turbines. One megawatt of regulation by flywheels is the same as two megawatts of fossil fuel regulation. There is a considerable reduction in greenhouse emission, about 70% to 80%. There are vendors who have a commercial proposition and they are ready to enter the market. Some have done that in PJM and in New England ISO.

Batteries have entered the fray. There are now four 1 megawatt units of lithium ion in PJM and California ISO. There are two 1-megawatt units of flywheels. A 20 megawatt flywheel system has been initiated in New York State, and another started in Illinois. These systems are beginning to move from experimental units into fully functioning commercial units that people intend to make money from.

There is a serious regulatory issue because current regulations among the ISOs simply aren't set up to deal with anything that responds

really fast. So, under the FERC leadership, ISOs are being encouraged to work out market structures, signals, control algorithms and so on so that fast storage can play on an equal base.

Next area, peak shaving energy management upgrade deferral. This area is near commercial. A West Virginia power substation had reached its maximum capacity, and the choice was either to rebuild it, which would have been double the capacity, when only 5% or 10% extra was needed. The choice was to introduce a 1.2 megawatt six hour sodium sulfur battery. It restores energy at night and lowers the peak during the daytime. It is nearly cost effective mainly from the deferral of capital expenditure. There are also any number of benefit streams that are very difficult to rate base. Three more of these have been built, all by AEP. They are two megawatt sizes with slightly different applications. Not just upgrade deferral but reliability, a platform for renewables, etc.

Next area, renewables dispatch, smoothing, ramping and peak shifting. This probably will be one of the more serious applications for energy storage due to the plain unreliable nature of renewables. [Laughter] The flutter from renewables looks very much like what we are used to on the grid anyway. If California goes to 20% renewables, they will roughly double the need for regulation. We have already shown that we can handle regulation with storage at a reduced carbon footprint and with greater efficiency. The next problem is ramping. Geographical diversity will not always wipe those out. Data from BPA has ramps that occur across the system. Storage is one way to do it.

Anti-correlated wind blows basically where you don't need it. The time when the wind goes down is exactly when the load goes up. This would be very convenient for storage to handle. The situation is even worse. In Texas they get into negative prices 900 times within one month. That's a problem. Storage could help them there and recover spilled wind and put it back into the mix. The question is should it go with a wind developer or is it a function of the grid? The wind developers would much rather like to have it as a function of the grid because then they don't have to pay for it. The rest of us have to. If the wind developer were to profit seriously by it then he might be tempted to put storage up.

Similar situations occur as far north as Chicago where there are negative pricing intervals. They're becoming a more and more serious problem. Storage is not yet a big piece of this. However, there is a one megawatt six hour facility up in Minnesota which goes along with the 11 megawatt of wind. The biggest one that I know of is in Japan where they have 34 megawatt seven hour storage with a 51 megawatt wind farm. They want to put the entire nighttime production into storage and have completely dispatchable wind during daytime. Japan needs their pumped hydro and dispatchable power. They cannot handle the ups and downs of wind power. They require new wind developers to invest in storage, but the gov't pays one-third of the cost.

A new idea that is coming up is community energy storage. Why not do little units right next to your transformer? This has good consumer acceptance because it looks like nothing. You have one of those serve four or five houses. It will guaranty a backup. It will serve as a platform for rooftop solar, for example. They can be ganged up, aggregated into a system that is dispatchable by the utility. If you have 1,000 or more of those, it gives the utility a fairly nice reserve to call upon.

If you want to go bigger you need compressed air. Compressed air is a mature technology, but there are only two in the world. The most recent one is about 30 years ago, etc. In the stimulus funding there are two case projects of 450 megawatt in the stimulus package which will more than double the world capacity of compressed air energy storage. There is a lot of interest in this field. We will see at least three new plants in the U.S. over the next five years. If you want to get really big then you get into pumped hydro. These things are big, 440 megawatts. The US has 20 gigawatts of pumped hydro. Europe has 32 gigawatts.

In the US there are 15 to 30 gigawatts proposed, and we will need most of those to accommodate

the new renewables. It is particularly so when you go into some of the more elaborate schemes. There is a proposal to collect wind from all these upper states in Canada, get it into a pumped hydro facility and then a DC line to Las Vegas and Los Angeles. This would span almost a third of the US.

Now, the stimulus package has had $200 million in storage projects with DOE. There are three large battery projects, a total of 53 megawatts with DOE, two compressed air storage projects, 450 megawatts. There is one frequency regulation project with flywheels, 20 megawatts. Then there are small distributed projects of a total of nine megawatts. These are largely to allow utilities to try it out.

We will need storage wherever you can possibly stick it. Distributed storage, distributed generation, and distributed intelligence. That way you get a fully resilient and safer grid for everyone. We have to make energy storage ubiquitous on the electric grid.

Question: How much storage of each type do we need throughout the US footprint?

Speaker 1: That is difficult because, as was mentioned, there are other ways. There is demand management. There is gas turbine if you want to go that road. There is rooftop solar which can play a role with a lot of Smart Grid. The exact percentages are not clear. 25% of renewables has been suggested as a goal for storage to back them up and smooth them out a little bit. For regulation, I see no reason why all regulation should not be done by storage.

Question: How much would that be?

Speaker 1: I don't know exactly, but it's been suggested that 100 megawatts can take care of California. That has come to 200 megawatts or so with renewable penetration. The point with the regulation is not so much that it is a humungous market, but it may be the first market that storage can penetrate economically and get utilities used to thinking in those terms. It's a big paradigm shift to suddenly think that you have this new thing that is neither generation nor transmission.

Question: For the 40 megawatt storage plant in Alaska, how long can that run for?

Speaker 1: I think it's geared towards 15 minutes, because that's all it needs.

Question: You have a 70% to 80% greenhouse gas reduction figure on regulation. What is that based on or measured against?

Speaker 1: A KEMA study.

Question: So would I be correct in saying that the 70% to 80% savings is because you're not running fossil fuel to do it?

Speaker 1: Yes.

Question: When you said that all regulations should be done by storage, is that assuming that the ISO would manage those directly, or is there an intermediary there?

Speaker 1: It would be a merchant plant or a utility.

Question: I mean in terms of the actual dispatch. When the dispatch signal comes from the ISO, does it go directly to that facility or does it go to the dispatcher who then dispatches it?

Speaker 1: It goes directly to the utility.

Question: You said storage is impossible to rate base. Is that all storage, whatever application?

Speaker 1: It's not impossible, but certain aspects cannot be rate-based. And it depends on how the regulation is set up. In general, for those plants, if they were to count arbitrage then that could not be rate-based because that would be considered generation even though it's both in and out. That's why they have put it on reliability and deferral of capital because that can be rate-based.

Question: If these plants are supplements to or alternatives to generation, who should pay to

connect them to the grid and who should pay for variations in market rules to accommodate them?

Speaker 1: I have no idea. [Laughter] The connection ought to be handled by the plant, presumably. Who should pay for the connection? An analogy would be who pays to connect wind power?

FERC is urging the ISOs strongly to change their rates. The main problem, for example, in California is that their computer algorithm cannot recognize negative numbers. They can only recognize positive amounts of energy that goes in. They cannot pay for negative numbers, which of course if you down regulate it's just as useful as up regulating. So somebody has to rewrite the computer program, but that's not that expensive.

Speaker 2.

We're talking about making the electrical conversion more efficient, but also crossover between the energy streams that are going to generate electricity and power for our vehicles. In the absence of hybridization nearly 100% of energy for transportation is coming from oil. These technologies will change more than just the electric grid..

There are three nice results from storage: load leveling, fuel efficiency, and portability. The mass and the volume are very important.

Lithium ion is around $1,000 per kilowatt number right now. Flow batteries and sodium sulfur, are very expensive. There are no economies of scale with that yet. The flow battery technology is a cross between a battery and a fuel cell with a central unit doing the electric conversation, and all of the electrochemical reactants stored in an electrolyte phase. Whereas batteries that we use for electronic devices in storage generally have a limitation to the total amount of energy that you can store in it for a given amount of power because of the limitations of getting reactants to the electrode surface. With the flow batteries, we're able to completely decouple the size of the power rating that we have and the energy storage. Here the power is determined by the size of your engine, as it were, and the electrolyte storage tanks are basically the size of your gas tank.

Engineers are trying to find inexpensive materials, inexpensive couples that provide the potential energy difference and a sufficiently large voltage there. They need cheap and durable electrode materials that provide rapid kinetics.

Carbon felts can actually be made quite cheap. These are materials that we know how to make and that can be quite inexpensive. The cell designs optimize the electrode utilization and minimize the external pumping and control requirements. Good engineering is going to come into this field here. So far, the technologies and the are still relatively immature.

Electro chemical energy systems are a means of storing electricity, that allow us to decouple the primary source, to recover more wasted energy, but the rates and the storage capability still need to be improved. The materials and engineering go hand in hand. The flow battery and the new battery technologies are quite promising. They have gotten rid of the requirement for energy per unit mass that we have in portable systems.

There's a difference between fuel cells and batteries. The fuel cells require an open loop system. Everything they are basically expelling as a byproduct of the energy conversation process has to be environmentally benign, they have to be able to be expelled out into the environment. With energy storage it can be a closed loop system. They can tailor not only what the reactant is but what the product is, and it improves options considerably.

With renewable penetration, there is an opportunity for a price differential that can be captured and an opportunity for some of these new technologies to have new uses. The research and development, the enabling technologies can allow us to figure out when one

kilowatt hour is worth more than another to end-users. There are extensive opportunities for added value in this technology.

Question: Nobody talks about storage as a value for coal plants. They cycle down to minimum loads at night, but if they can run the coal fire plant full out it has better efficiency. Is this just a cost issue or is it just not trendy to talk about coal plants?

Speaker 2: There is less of a cost capture there than the differential cost of wind or something like that. If we bring the cost curve on storage down sufficiently there is likely to be more applications like that where it does allow you to optimize the overall efficiency of the system.

Question: It's a market clearing price so there's a uniform price, so it doesn't matter whether it's wind or coal, right?

Speaker 2: Right.

Speaker 1: The stimulus funding has a small town research project, they want to more efficiently utilize their coal plant, and they're going to install storage to do just what you said.

Question: How important is the energy balance for these technologies in driving their economics? Where is it today? There is pumped storage in New England, Northfield Mountain. It has 1.4 megawatts to get one megawatt out in the next cycle. What are these other technologies looking like now and how important is that in the economics?

Speaker 2: We're looking upwards of 80% on the systems that I've seen, but we really want to get above 90%. That's attainable.

Speaker 1: 70% to 90%.

Question: 70% to 90%. In an economic analysis of the different technologies as they proceed towards commercialization, is that a driver?

Speaker 2: That's part of the cost. You need to insure that you're not losing that energy in the transfer there. So that's absolutely one of the key parameters that needs to be addressed.

Speaker 3.

I'll discuss some of the policy challenges that storage is facing, and talk about compressed air energy storage. There are two key policy challenges. One is a lack of consistent incentives for development and commercialization, with an uncertain federal and state regulatory terrain. Second, depressed energy markets and tight credit markets which have made it more difficult to innovate and commercialize some of these technologies. The government and the stimulus program is playing a critical role right now, and it's necessary.

Until recently storage wasn't viewed as an essential component of the energy mix. I'm going to look at the second generation of the CAES technology. It is taking energy and storing air either above ground in small containers or underground in salt caverns and then heating that air and releasing it at times when you need. It's stored at the off-peak and used at higher peak times. It can help certainly with intermittent renewables. It's also helpful in places where you have high peak capacity issues and possibilities of shifting some of the supply so that we can meet peak demand.

Energy storage is not really transmission and it's not really generation. It's not clear how this should be regulated, what the appropriate incentives are, and what the interconnection role should be. It converts variable renewable resources into firm dispatchable power available when customers need it, so there is an important role there. It can enhance greater reliability which we think is increasingly important with renewable resources becoming a larger part of the supply. It has a role in optimizing the utilization of transmission. One concern is to make sure that there isn't a rush to overbill transmission when there are these other options out there that might be more efficient in the overall energy scheme.

There are a number of stakeholders, as usual, when you're trying to develop new public policies. There's activity on a number of fronts. First, Congress has an important role right now in providing financial support for nascent technologies. Second, there is an important role for the Department of Energy, both in the technology validation, as well as project financing through loan guaranties. FERC is going to have an important role determining what the right rules should be for providing storage with its full economic value and reliability value, and maintaining the markets.

We've heard about DOE funding so I'm going to skip over that. Obviously important though. With federal legislation there will be broad incentives to reward low and zero carbon technologies in the cap-and-trade legislation. We do need a price signal that is going to help make investment decisions that support lower carbon and renewable technologies. There is money for research, for clean technology which includes storage, there is money for loans to manufacturers of storage facilities, and there is a fair amount of money would go to states under cap-and-trade regimes through the allowances which would allow that funding to be used for storage.

Second, there are federal renewable portfolio standard proposals in the Waxman-Markey bill, and also on the Senate side. Support for renewable energy will drive the need for greater storage. There are proposals in the energy bill for the Green Bank which would provide a longer term source of financing. The stimulus is a kick start but a longer term loan guarantee is also critical. The most important element is to deal with the tax credit issue. Right now storage is not eligible for investment tax credits. There is a bill called the Storage Storage Technology of Renewable and Green Energy Act of 2009, Senator Wyden's bill. It would provide an investment tax credit of 20% for storage facilities that connect to the grid and 30% for storage that are used in residential and commercial facilities onsite. This sis really critical, just as it's been critical for solar development. Obviously, it's a financing subsidy by the taxpayer. And it is recognition of the role these technologies can play in trying to facilitate renewable development.

One of the reasons that wind has taken off so well is because of the Production Tax Credit. Unfortunately, under the provisions of the tax law, if a wind developer wants to sell its energy it develops or put its energy into storage it will lose the Production Tax Credit. It's only valid if it goes directly into the grid. It's a complete disincentive to having any storage. This obviously needs to be rectified.

It's not clear how that happened. Why would you want to discourage something that could increase the efficiency of the wind energy?

Finally transmission policy could undermine the ability to use some of these other mechanisms. A socialized superhighway will make the economics less possible for storage. That's a real concern.

FERC's role is to address jurisdictional issues because some of the storage is done at the distribution level, some of it is done at a transmission level. There is this overall question, is it generation or is it transmission? There is authorization under Order 890 that storage is supposed to be taken into account in transmission planning and through the RTOs. More could be done to help folks understand what the potential of storage is, and then to wrestle through the stakeholder processes to figure out the appropriate treatment. FERC needs to make sure storage is part of the broader conversation concerning transmission, renewables, and integration.

There's a question about how much storage could reduce the cost of intermittency. If you overbuild transmission and put in extra capacity there there's a cost to that, it's just not explicit. And so what we really need to do is to make sure that the costs of these different options are explicit so we can make the right decisions. So, yes, there is a cost to storage, but there is also a cost to excessive transmission.

Let me address the role of states. Economic development agencies are interested in this

technology, the same as with renewables. States are important from an incentives, manufacturing, and permitting perspective. CAES uses energy to save energy so there are issues with emissions in terms of state environmental goals. We'll need an efficient state and federal interaction to make this all work.

There are always some winners and losers when new technologies come onto the forefront. This is an area that warrants development, especially in terms of the carbon and renewables question. Storage will need some investment tax credits, removal of the wind production tax credit disincentive, climate change legislation, a reasonable transmission policy that isn't going to crowd out these other opportunities, and approval of this clean energy deployment and longer term financing to make this sustainable.

Moderator: Does the Storage Act discriminate against the storage of coal generated energy explicitly? Second, for production tax credits, how would you or the IRS know where the energy was going, whether into a battery or not? How would the law be enforced?

Speaker 3: I don't know for coal. For a green transmission highway, how do we know where the electrons go? With the PTC, that's a good question.

Question: If you have the battery right next to the wind turbine and it stores the energy, you don't collect the Production Tax Credit?

Speaker 3: Yes.

Moderator: In the context of taxes, when you sell wind into the grid you get a rec, a verified transference into the energy. That's Texas-based, other states have similar programs.

Speaker 4.

I'll jump right to battery storage, particularly the lithium ion approach. It's good for safety purposes and also depth of discharge, cost, deployability, things like that. I have encountered a flow battery, that was leaking vanadium. And sodium sulfur is a good technology if you have it deployed, perhaps a switchyard where you've got really good control, but it does operate at extremely high temperatures. The lithium ion batteries developed for automotive use are, by definition, relatively safe. They don't want people dying that survive car crashes from the battery fumes.

It's not a transmission or a generation asset. We need to start calling it storage. [Laughter] Reservoirs are very important in the distribution of water. So we need to evolve our terminology a little bit. Storage should occur at really all levels and if properly deployed can increase the efficiency and value of the electricity. It would play an integral part in the Smart Grid.

Battery storage and safety can drive the site location. Lithium ion, you can put the battery systems anywhere you wish. Sodium sulfur, because of the operating temperature and the size is pretty much switchyard territory. Flow batteries are large. They have fluids and pipes and things that can leak and whatnot.

Roundtrip efficiency varies greatly by battery type. Lithium ion batteries are highly efficient. The battery itself is 92% efficient. Then you've got to figure in the power electronics, which I'll speak about in a little bit.

Cycle life varies in order of magnitude. The big drawback with lead acid batteries is a limited cycle life. They start to degrade in terms of storage capacity pretty rapidly. The depth of discharge is very important. The lithium ion batteries can be discharged 80% without damaging the battery. You cannot go that low with a lead acid battery.

The lithium ion batteries are rated at 3,000 cycles, but up to 4,700 cycles. At 3,000 cycles, if you cycle daily it's an eight-year life. With a battery management system, along with intelligent control, a smart company can get ten or more years out of the batteries.

Scalability is achieved through intelligent control. Most are small model, 20 kilowatt. There's work on a 100 kilowatt unit with 400

kilowatt hours. That unit could be clustered into megawatt level storage with ten or twenty together. Through intelligent control you can dispatch power from a large number of batteries all at once to get firm capacity improvements through scalability.

Maintenance and support differs widely among battery types. Again, the lithium ion is a low maintenance solution and doesn't require specialized technicians. New chemistries offer lighter weight and small size.

There are different chemistry types within lithium ion. Ion phosphate is the least volatile. It is not like these laptop batteries that blew up. These have been tested with nails being pounded into them, guns shooting them, lowering the batteries into a blast furnace, and they don't explode. They melt eventually in a blast furnace. Water is used as the solvent and they are highly recyclable. The batteries don't even look like something you want to throw out in the first place, but they are very highly recyclable. They can recapture just about all the valuable materials in them. Lithium is a very light-weight metal and it offers high density storage, deep discharge, and long cycle life.

The systems I'm discussing, at the current charge and discharge rate, use a three-to-one ratio, meaning if you have a 100kW inverter you'd store three times as much power as that and release it over three hours. You'd get 100kW per hour out of the battery system. There are technologies being developed for nanotechnology being applied to the anodes that will allow the discharge to be much more rapid. You can discharge them more rapidly infrequently and get away with it, but if you discharge them rapidly every day you'd damage the cycle life. It's a decision to make with current technology. In three to five years the technology for rapid discharge should be available.

The power electronics now have up to 96.5% efficiency with some improvements still possible there. The total round trip efficiency is just under 90%. That's superior to most other types of storage. By providing measured output to the grid, transmission and distribution efficiency gains can be realized. We need to see more simulation modeling performed in that area to identify the value streams associated with that. We're seeing the cost go below the $1,000 per kilowatt threshold that EPRI defined as a stake in the ground. The cells are large format prismatic cells, as opposed to the cylindrical ones that some manufacturers are using, which are more expensive. The combination of shape, advanced controls, long cycle lives, and high efficiency make the costs go down.

The cost of battery storage will continue to decline sharply. So, if you're doing a ten-year generation planning or considering generation assets that are going to operate 40 to 50 years into the future, ignoring storage is not a smart thing to do. What the utilities need to do is demonstration projects that show how it works in concert with other assets. The costs will lower in future and storage can be used as one of the planning tool building blocks, if you will.

It took about 100 years of battery use to double the capacity of batteries. They doubled again in 15 years. And we expect to see quadrupling of capacity now in the next 10 to 15 years.

These kinds of systems can be used in both a centralized or distributed manner. Clustering allows centralized storage. A 25 megawatt solar PV farm can have clustered units set up in a shipping container. The value of distributed storage involves not just the load shifting but also avoided grid congestion by storing the power out there at the edges. It's not unlike what we did with telecommunications ten or twenty years ago where we put intelligence out at the edge of the network. The complexity of control is lessened because there's more control happening at the edge. It reduces the challenges of centralized control. My view of Smart Grid is if you try to just only do centralized control you'll be overwhelmed by the complexity. So storage is a way to reduce the complexity at the edges of the grid which will enable intelligent control to be exerted from the center more effectively.

Base generation is facilitated with storage be it nuclear, coal, it really doesn't matter. If you've got excess capacity you can store it and release it during peak. Also with intermittent generation, solar and wind, it's being generated perhaps at a time of day that isn't most effective, so store it and release it when the value of the electricity is the greatest. So, depending upon the application, storage may be viewed as transmission or a generation asset. That complicates things from a regulatory perspective, but we've really got to think that through and recognize that maybe storage is a new category. It's a very valuable asset that can help the overall efficiency.

AEP did an analysis of the value of storage depending upon where it is in the grid. The value curve increases right up to the meter. The greatest value of storage is right out at the edge by the meter, the utility side of the meter. They coined a term *Community Energy Storage*. A box that was sitting next to the transformer in the neighborhood. Something the size of a mailbox can provide a 25 or 50 kilowatt hour. With the clustering ability of lithium ion and intelligent control, megawatt level storage is possible for distributed generation assets. This smaller level storage can work in conjunction with large level pumped hydro and compressed air.

Reducing complexity allows one to exert intelligent control, enable Smart Grid, make generation, transmission, and distribution more efficient. The industry has historically focused on centralization. The Smart Grid is intended to address these kinds of control issues. Distributed generation introduces control challenges that may overwhelm centralized control, and storage can be a way to buffer those impacts on the system.

Enterprise risk is interesting. When you look at generation assets and the planning horizon and the fact that generation assets will hopefully perform 40, 50 years out from a ten-year planning cycle, the game is really changing. If we assess which type of assets will see a major cost reduction, it varies. Coal and nukes will probably be more expensive. Natural gas may stabilize with these new supplies, wind may improve slightly, maybe 25-40% better. Solar has the capacity for improvements on an order of magnitude, as does storage.

The Chinese have announced an 11.4 gigawatt PV solar array in the Northern part of China. If they build that much PV solar the price will come down. It's going to be like flat panel TVs, they were real expensive, and now they are the norm. I expect the improvements in solar and storage to work together hand in hand. Storage is a very important component to be able to deliver firm capacity when you generate intermittent generation assets. When doing the generation planning there has got to be serious consideration, will generation plants live out their planned economic life? Storage can help reduce enterprise risk when it comes to generation assets in their economic life.

Storage can defer decisions on construction with traditional generation assets which allows time for new technologies to mature. It can defer construction of some transmission assets which is particularly valuable in constrained areas. Northeast United States has enormous transmission constraints. It can reduce the capacity of transmission assets required for intermittent generation by smoothing delivery and can reduce investment required for peak and generation assets and related greenhouse gas emissions. It can improve the economic efficiency of base and shoulder generation through enhanced value of off-peak generation and delivery of that generation during peak.

Storage value streams. There are additional societal benefits, including reliability of electrical supply and reduction of greenhouse gases. They are hard to quantify. The reduction of enterprise risk can have significant value.

On policy, we've got to figure out what it is. It may be transmission, it may be generation or it may be both, or it may be just something new we call storage. Storage technologies need to be fully considered under pending and future legislation, similar to renewable generation. There is some storage language into the Clean Energy Act, which is stalled in the senate, and also in the Solar Technology Roadmap Act.

Pilots need to be encouraged through grants so storage can emerge as a powerful building block in utility strategy. These are not particularly expensive projects. They can demonstrate how these work, quantify the value streams for utilities. It is not multi-billion dollar stuff at all. It's pretty inexpensive. It will facilitate creation in new economy, clean tech jobs and exportable technology.

Question: It sounds like most of the funding today for the development of storage comes from speculative activity. There is not really a market specifically for products that deal with storage directly. One highlight was high frequency regulation. It's not a separate product. There is regulation, but that is meant really for direct control based on plants or gas fired plants. What types of new market structures or products are needed for kind of maintaining an industry that invests in battery technology on an ongoing basis? Second, does storage suffer from the same issue related to these products that transmission does? Price signals can tell you where you need it but once you put it in the price signals are eliminated from a revenue perspective. Once transmission is in there the price differential between locations essentially vanishes and you don't have a revenue base for a market product to get revenue off.

Speaker 1: On the ancillary markets, frequency, etc, they're established markets and you get paid per kilowatt capacity and kilowatt hour.

Question: Like a tariff rate, right?

Speaker 1: Yeah. That keeps going. I mean once you have built it hopefully it becomes a cash cow, or maybe not quite but, nonetheless, it will continue to pay off.

Speaker 3: It would happen until you meet an equilibrium. So if there was a big division between the peak price and the off-peak price you'll get storage up to the point where it makes sense and then you won't need as much storage. Right now it appears there are some big differentials that could be arbitraged.

Question: One aspect would be how much capital deferral can you get as a utility through deployment of storage of other assets like generation assets you might have to build if you didn't have storage. Storage may indeed be less expensive. The value there might be a deferral value, a capital investment deferral value. You might spend $1 billion on storage and avoid spending $10 billion on something else.

Question: You put it as part of a package in a rate-based application or in the development of an asset that is needed for the system, and it would just be rolled into the plan that it's more cost-effective this way and the capital gets recovered with a rate of return.

Question: One incentive for the regulators might be carbon credit activity. Effective deployment of storage could be very useful in a carbon market.

Speaker 1: The industry's asset utilization is lousy on everything, including transmission and generation, and likely to get more so. If a utility puts 5% of investment into storage, and cuts off 25% of the worst problems off the top, they get much better asset utilization on the transmission. How much that is worth, taking into account NIMBY responses to new transmission, is hard to say, but storage may be a real improvement.

Speaker: In terms of regulation, are we probably valuing faster response or slower response? That's maybe a question. But I'm not clear that we need a fundamentally new market. Regarding eliminating the price differences, transmission is thought to eliminate the price differences because you have big chunks of it, right? Storage technologies will come in much smaller increments so that an equilibrium is easier to imagine coming about, it's not lumpy and therefore less of a concern.

Question: Calling this storage is a nice simple way to do it, right? Just create a new asset category. Does that require a legislative change on the state or federal level? What kind of jurisdictional issues could that potentially create? Is it state or federal? How would it work?

Speaker 3: A whole new category would need some legislation because there is references already to storage in the existing law. To make a change to that, you'd probably want to clarify that. This is something that FERC should be wrestling with. There is a lot of history and litigation in the debates over transmission and generation. It may not make sense to come up with a new category. A regulatory and rulemakings approach would be a better mechanism than some kind of broad brushed legislative approach.

Speaker 1: The term advanced transmission has been suggested by a number of people which is almost a new asset class but not completely.

Question: That gets an incentive rate of return at FERC which is why some people want to call it that. Do we create markets that these products can access or enhance the markets that are out there like the ancillary services markets? If one wants it in rate base, you do it on a case-by-case basis. I mean is it that simple?

Speaker: I'd prefer to create a market only for something that somebody actually wanted. A need really needs to emerge first.

Speaker 3: In areas with competitive generation, we have to be careful that we don't put that at a disadvantage, all of a sudden throwing storage in there which is a substitute to generation without recognizing the effects that it could have. That's why this is so complicated, because we have different regulatory regimes in different parts of the country. There are a lot of benefits to get out of storage, but it would be a very bad side effect if it were to disadvantage merchant generators.

Question: A lot of this is discussing really good storage, smart, efficient storage that's up to scale. How about not so efficient, not so smart but profitable storage? There are lots and lots of locations in PJM where the price swings by more than $100 per megawatt hour the cycle of a day and maybe more than $200 over the cycle of a day on most of the days. If I had a lead acid battery or a lithium ion battery on a trailer and I could tow it to that place, and as long as those conditions exist I could buy and sell extensively, and then when the conditions changed I'd tow it to someplace else. Why isn't there a shortage of trailers? [Laughter] Why don't people take trailers of toasters to West Texas and plug them in when the prices are minus thirty. It's the same deal, right?

Speaker: That's the thinking behind the containerized megawatt level storage that I was talking about, put it in a container so it is transportable.

Question: But why isn't it happening now?

Question: Well, we're just getting there. [Laughter] We just invented this stuff.

Question: No. We've had crappy batteries for a long time. We could have done that a long time ago, right?

Speaker 1: If you want to finance it, go right ahead. Niche applications that take care of local situations are great because eventually they will show people that it works and then they can put better and more cost-effective storage into place. It is not happening now because, first of all, utilities are very conservative and the structures for independent merchant trailer trash are not really there.

Question: Why not? I mean all you have to do is hook up, right?

Speaker: In Texas the structure for independent merchants is definitively here.

Speaker: One possibility is that it's actually not that cheap.

Question: I am being cynical, it would take you several months to get a meter wherever you went to. And your interconnection request on the generation side would probably not get processed in time for you to do your arbitrage. There is a transaction cost. It's huge, and long, and complicated.

Speaker 1: The philosophy behind the substation application is exactly that. A utility would have a fleet of these. When they decide which

substations need to be upgraded they would just put the fleet there, run it for three years and then see whether the load growth has been sufficient to really require an upgrade. If the answer is yes, then they can take that trailer and shift it over to the next substation that needs it. It still turns out that this particular substation, which was only supposed to use the storage for three years, is now estimated to be in the five year range. But, even so, with a 20 year guaranty of the batteries you could get three or four different locations out of it. Their capital investment becomes less and less.

Question: We have not explained the fundamental commercial conundrum as to why people aren't making money on this already, unless the hypothesis is that the batteries aren't as cheap as what we're imagining.

Question: It could be a combination of both things, which is they aren't as cheap and then you do have transaction costs.

Speaker: Everyone who has tried to update the MISO model and make sure they have plenty of time to test it would tell you it takes probably about three months just to make a small change in the network model that the ISO uses to calculate prices. You would certainly want to have your storage facility in the price model. It would take you probably six months to move from one location. The permitting, processing is enormous, the transaction costs are humungous.

Question: Well, if you're a large industrial customer and you plug this thing on your side of the meter then all this stuff is irrelevant. They see the same price swings and there's no transaction costs if they do it on their side of the meter, so why isn't there a shortage of trailers? Of course, they want to get paid twice. [Laughter] That's the demand response story. It seems to me there are niche opportunities there.

Question: At the Chicago NARUC meeting there was an electric EV truck from the University of Vermont. They were selling regulation services to the pool. They got so many dollars per day to support this little truck.

Question: I'm talking about something really dead simple. I plug in my crappy battery and suck the energy when it's cheap and put it back in when it's expensive get paid for it, or reduce my costs at a minimum.

Question: Cheap lead acid batteries would need an enormous trailer, and a lot of maintenance. It probably isn't cost effective with the crappy batteries. On the other hand, with the new technologies, and lithium ion, this would be a great approach.

Question: There is a boat load of money being made in gas storage on swings in prices that are seasonal, weekly, weekend versus daily gas prices. Again, why aren't people taking advantage of that?

Moderator: And people get shocked by a factor of two or three with gas, right?

Question: Right.

Moderator: Whereas, we're talking a factor of 100 with electricity.

Question: Yes.

Moderator: Or a factor of infinity from negative prices to positive prices.

Question: And daily, hourly, minutes. So what's the regulation aspect of this and what's holding things up? Well, gas storage is classified as transportation on the gas side, which makes it interstate commerce jurisdictionally. What the FERC has wisely done is, in the last few years, basically said we'll certificate your gas storage facility but we'll let you do market-based rates. That takes a whole lot of the rigmarole out of getting this stuff done and worrying about it. You get the practical application, which is the reliability and the arbitrage value. Maybe we need the same kind of approach.

Speaker 1: Most of the CCS proposals would be doing that sort of thing. They're not worrying about rate-based. They just want to provide a service for which they get paid, period. We're going to see a lot more merchant ventures in this

because the utilities really don't want to be involved in the nitty-gritty of battery management.

Question: Plus, if you're a utility, they're going to limit what you can make. On the gas side, it's almost printing money.

Moderator: So perhaps that reflects a fundamentally lower cost of storage of gas than storage of electricity.

Question: Right. However the differences in price, especially with negative pricing, pay me to take it and do the arbitrage.

Speaker 1: For compressed air it's not really that different. In fact, former gas storage bore holes are being considered for CCS plants. You have to pump it in, you keep under 3,000 PSI, which is just like gas, and the only difference is that you have a gas turbine and that gives you maximum return. A gas turbine for CCS has about one-third the carbon output of a regular gas turbine.

Question: Why wouldn't you use an electric turbine or electric compressor?

Speaker 1: That has been proposed, but it is a new approach.

Question: Just speaking of transaction costs, I was wondering about the siting implications for some of these storage applications. Yesterday Shell just had a very large CCS project that's going underneath a town approved, but it's very controversial. This is in the Netherlands. I'm assuming there are some siting implications for large constructed pumped hydro facilities, but I'm also wondering what the siting implications are for small applications. Are there concerns for the heavy metals in the batteries? What about increased footprint? Are these less than, say, transmission siting issues?

Speaker 4: Lithium ion doesn't have the heavy metal problem. They're highly recyclable, with light weight. There's no liquid inside that leaks out. Other battery types have disposal issues and leakage issues and things like that. There are potential temperature issues with sodium sulfur. With the flow batteries you have fluids that can leak. Depending upon the battery type, you do have locational issues. That's why lithium ion is the most flexible.

Speaker 1: Locational issues are not nearly as important as they might seem, unless you're in downtown Manhattan. As far as compressed air is concerned, the company likes to acquire all the land under which you have a bubble. In actual fact they are thousands of feet down with serious cap rock. Nothing is going to happen. It's certainly not as dangerous as putting up wind turbines, for example. A fairly small footprint is possible with compressed air once there is experience in this thing. With most of the other technologies, there are potential risks but they are not more dangerous than a car. We have all kinds of dangerous chemical devices around automobiles. It's up to the provider, the local fire marshal, and underwriters to pinpoint these and come up with mitigation technologies.

Incidentally, lead carbon batteries are among the most highly recycled of any commodity. They are virtually 98% recycled. The commercial uses of lead acid batteries are almost totally recycled by the industry themselves, including the battery acid, including the lead certainly, and whatever else goes with it. And so one would expect technologies like sodium sulfur and vanadium to be doing the same thing.

Question: Just a clarification. The Netherlands project is carbon storage which is entirely different.

Speaker 3: Some of the early discussions on carbon capture and storage identify possible liabilities in terms of what happens underground a hundred years from now. Those are real serious issues. With CCS there are smaller capacity above ground tanks which are sited and managed easily. Underground it's salt caverns or aquifers.

In any case, it's important providers to start working with their states on the siting issues. It's important to get out in front of this and make sure people understand what the public benefits

of storage are and how it can fit into the overall energy package, and also for them to understand that the safety issues are significantly less. The storage industry needs to be in front of this.

Speaker 4: With flow battery configuration, even if you do get a puncture through the middle of the stack or something to where those two streams mix, the quantity of material there is very small relative to the total amount of energy that is being stored. So it's a relatively safe way of storing that energy, even in a flow battery. I'm more concerned about failure modes in flywheel storage because it's a huge amount of kinetic energy. There are mitigation systems in place for those, but the failure modes of these batteries are usually pretty soft.

Speaker 1: The flywheels are under ground in tanks. Even if they blow up, it's no problem.

Question: A couple of observations. One, a storage project in Texas has been sued over whether it is generation or transmission. So maybe we'll have some court decision which will at least provide some element of clarity.

I was intrigued by the comment that coal and nuclear plants are not likely to get cheaper. We've been hearing about low prices on solar for a long time. But if storage is a chemical process, how cheap can it get?

Speaker: It's a good question. Nanotechnology is being applied in batteries now which will provide revolutionary breakthroughs in cycle life and rapid charge and discharge. So it may not be as big a change in battery chemistry but in the physical structure. There will be advances also of battery chemistries. There is a lot that is not commercially available yet. Lithium air batteries, other things. The application of nanotechnology to batteries will be the big issue.

Question: So they're utilizing much less material for given power density, and that's accounting for the reduction in cost, is that right?

Speaker: Well, actually, no. The electrons will move extremely efficiently. It will allow rapid charge and discharge, much greater density of storage. And those are revolutionary breakthroughs.

Speaker 1: And you don't get the chemical degradation at the interfaces.

Speaker: With battery technology, the point where we get current to flow is when something moves across a boundary from the electrolyte into whatever the host material is there. Right now a lot of the lithium-type batteries require basically an atom of lithium to go into some type of solid materials, and there are volume changes associated with that. With a larger system, that leads to degradation over time. There's a volume change there and you basically start to crack apart these materials over repeated charges and discharges. And so when one looks at what the overall energy density is of lithium, they're staying in a very narrow range of what the actual possible extracted energy could be because they want to avoid the problem conditions.

Rather than getting all the energy that you could get out, they're staying in the middle 20% of the state of charge there. With nanotechnology you can start to accommodate those volume changes because it doesn't break apart larger particles. If you've got a very small particle to begin with and you can allow for that to grow and shrink on multiple cycles without permanent damage.

In terms of other materials, they are working to get away from requiring mass or volumetric restrictions. Once a larger element or device is possible, it opens up the Periodic Table. Now when they're considering chemistries, they look at cell voltage, but also what the scarcity of those elements in the earth is. They can avoid rare materials. Vanadium is one.

Speaker 1: Or unfriendly countries that have rare materials.

Question: Colorado is very interested in CAES projects. They just closed a 2 gigawatt solicitation from Xcel Energy. Their interest is driven in large part by the fact that Xcel Energy is at 20% heading to 30% in nameplate capacity wind penetration. They'll be at 15% wind with

all the intermittency problems too. Wind CAES will be very significant. I've been hearing about second and third generation CAES. What is this technology?

Speaker 3: The first generation was this technology that was used 20 years ago in Alabama and it's still around. The second generation is just higher speed. It's more expensive, the second generation, but more effective.

Speaker 1: In third generation you reuse an even higher amount of the heat of compression that you originally had. If it turns out to be cost-effective, we might have isothermal CAES where you don't use any heat. They can run it without a combustion turbine. You just run the thing hydraulically; compress hydraulically with a hydraulic turbine on the other end.

Speaker 3: The wind industry has not been a strong supporter of production tax incentives for storage. They argue that storage is expensive so it's going to increase the overall cost of everything. That is pretty short-sighted. One, the storage costs are going to eventually go down. Second, wind itself isn't exactly cheap, right? They're getting all these tax incentives.

Question: No. And their integration costs aren't low either, and they will tell you that as well.

Speaker 3: They need to find the right balance between them.

Question: The observation that the production tax credit was not available for wind that went into storage is news to many. Is that a private letter ruling? Do you have something specific, I guess?

Speaker 3: That's been the interpretation in the tax law. I'm not sure where it originates, but the industry is working on it in Washington.

Question: If I had a jurisdictional utility that came in with some sort of storage facility, it would be a plant. If CAES is there and it is an appropriate investment for the utility it would go under rate base. Now, Indiana is traditionally regulated. The treatment of storage would be simple there. What is the problem in market states?

Question: If it were transmission in Texas, it would be rate-based and owned typically by a transmission provider. And it would be uplifted. [Laughter] And if it were not transmission it would be at the risk of the investor.

Question: It is a local option determination then.

Speaker 3: Well, I think it depends. If you treat it as transmission in Texas or New Jersey then it's potentially putting the generators at a disadvantage. If it is acting as a generator and selling energy when it's valuable, you know, what about those generators who invested under their own risk and who will be harmed when that peak price comes down?

Question: So it's really only an issue for those people.

Speaker 3: I don't know. I'm not sure it's as much of an issue in the regulated markets. There has been more interest in storage in the regulated markets – the treatment is more clear.

Question: It's critical to understand that the flexibility is recognized and there is value to that. That's precisely why they should be considered generation assets. Capturing margins is what generators are supposed to do. That is the incentive to build and create these types of generation resources, and that is the correct pricing for real-time energy. We treat load this way now. Load is treated as peak shaving and paid generation prices. That's precisely the value that these flexible storage devices provide. As we get more comfortable with that flexibility and are able to deal with this smaller more distributed scale, we will see a paradigm shift in technology dislocation. In 15 years electric vehicles could be providing significant storage and ancillary services to the grid.

Question: How is storage transmission again? It's either a generator or a load, but I don't see how it's transmission. One of the things that came up earlier is about storage for regulation.

Why do we have to think about using storage in terms of batteries or compressed air storage when we have other forms of energy storage that are thermal? Water heaters, refrigerators, air conditioners can all be controlled and respond very quickly without having to create any more infrastructure. Expanding the purview of what storage really is for the purposes of operating the power system should be addressed. If they had control over a lot of the air conditioning units and water heaters in PJM, they wouldn't need to have steam units providing automatic generation control. They could do it with those storage devices as we stand today probably.

The other issue is with respect to intermittent generation and storage. There are some tradeoffs here. Imagine storage in Minnesota, sited at the same spot as the wind farm. Now, that's great when prices are negative because now you're financially in a wash. But what happens if that asset is far from load still at peak times? We've still got congestion. What has that storage gained? They're still going to have to dispatch more expensive resources closer to the load, or build more transmission anyway.

Question: But the wind is not blowing at peak. It will transport during the night and then store it near the load.

Speaker 1: Thermal storage certainly can play. Making ice at night is great. The trouble with doing it in your hot water heater, of course, is that you cannot get energy out. You can only not load into it.

Question: Let's use thermal storage as a regulating resource rather than as an energy storage resource, so being able to turn on groups of hot water heaters across a wider footprint or groups of air conditioning units.

Speaker 3: They have that in New Jersey. AC cycling, right? They have those types of things. There are certainly some companies out there doing the ice storage.

Question: Yesterday we talked about the idea of a national grid and this idea of generating power in one part of the country and through displacement, moving it across the country and the amount of money that it would cost. Today we're talking about basically localized options which are mostly storage options. We heard about a process to allow storage to compete against transmission on a level field. What's the process that you have in mind? Can you give us some examples?

Speaker 3: Earlier in the year we heard that we had to build this green super highway to make sure we could access Midwest wind. Once you build a transmission network, if you overbilled it you're stuck with it. There's high capital, and siting issues. We have to ensure storage is part of the overall picture. It's entirely possible that storage could allow for transmission during off-peak hours with current facilities. The fear is that the push for a green superhighway will pre-empt other possible solutions like storage that could be cheaper and easier.

Question: Is this process going to be at the regional level within the ISO, or at the national level, in Congress?

Speaker 3: That's part of the debate that Congress is looking at. What's going to happen with planning and whether there should be two big planning regions. I think we should work within the regions with some oversight by FERC, but to keep it a more regional local level. Transmission in New Jersey is a whole lot different than transmission in Texas. A process that is flexible and allows for multiple options is better.

Question: We adjust generation to fix frequency problems, we don't adjust frequency. Can someone address that? Second, what's the sustainability of the solutions? This is a 24/7 problem we're trying to solve Do 15 minute or 3 hour solutions fix a 24/7 problem?

Speaker 1: Regulation purely addresses the flutter. It does not address bringing on power plants over the course of the day.

Question: Right. Well, regulation would be like your fine-tuning around your balancing, right?

Speaker 1: Yes. There is 15 minutes of storage in there, but the point is that's the cycling. In general, you do this only for a few minutes and then you load up again and you have many cycles during the day. This is not just a one-time thing.

Question: So I'm still not understanding what it means to adjust frequency because you're adjusting generation and demand to address frequency. How long does it take to get 15 minutes' worth of solution?

Speaker 1: You generally don't have 15 minutes in one direction. It's just every 15 minutes it's got to work out. The cycles are much shorter and they go up and down and up and down. With a 15 minute energy reserve you can do 90% of the needed control of flutter continually.

Moderator: Would it be correct to say that for your 20 megawatt device you've got 5 megawatt hours of energy storage capability?

Speaker 1: Yes.

Moderator: It's 15 minutes to charge it up from scratch and 15 minutes to discharge it.

Speaker 1: Generally it will happen more frequently.

Question: I'm confused about transmission and storage and generation and the criticisms of transmission and to go slow. Isn't the bottom line providing low cost for consumers? It seems like the arguments that I'm hearing against transmission are more focused on protecting existing generation and economic development opportunities. Transmission doesn't compete with generation. It facilitates other generation interconnecting into the grid. Certainly there's a cost associated with that. Having transmission competing with storage; they're both facilitators. Obviously, the cost should be compared. There's been no rush to judgment on transmission. We haven't built any major transmission in the United States in 20 years. No transmission is going to get built tomorrow either. It will take the next 10 to 15 years, if it does get built at all. What is the ultimate benefit here?

Speaker 1: You're right. The concern is for fantastic wind development by humungous transmission lines throughout the United States. The T. Boone Pickens sort of approach.

Question: If there are opportunities to develop high-quality wind in the Midwest and facilitate that with high voltage transmission, then we just need to do a cost comparison right?

Speaker 1: Yes. But you can do the same thing with storage. There are studies of how to bring wind from West Texas over into the Houston area. You can either build a lot more transmission or put storage in which will allow you to load existing transmission lines fully at all times or a combination of both.

Speaker 3: The concern is when the proposal is socializing the transmission costs you lose some of the cost signals there. A cost comparison does make the most sense. We have to be very careful in making these very large chunky investments. Once those go forward, they may preempt other more efficient solutions. Especially when we keep hearing about new solutions in both storage and solar, it might be smarter to create short-term, much cheaper solutions with storage and see where the grid takes us. Storage opportunities can bridge us to further technology advances.

Question: Right. If customers are being shown a price that incorporates the true cost of the wind in the Midwest and the transmission then the cost allocation hasn't been resolved.

Speaker: They're not.

Question: The cost comparisons have to be resolved or it's not going to get billed.

Speaker: Surely not. One would never build wind on the basis of lowest costs unless you internalize the carbon costs. It's plainly more expensive to build a ton of wind and transmission compared to building gas turbines and combined cycles.

Question: The position that you want to minimize the cost to customers is not a valid

presupposition here if you're talking about wind. They need to internalize the cost of carbon or forget that proposal.

Speaker: Exactly. A national RPS, a price for carbon, and obviously the economics are going to change. The problem with those simplistic maps which show the country webbed by 765kV lines is that people on the Hill take those things seriously. Suddenly you've got policy rushing off to do that very thing.

The general principle that we're shooting for a longer term least cost solution is correct. However the large 765 overlay does not address serious cost comparisons.

Question: The benefit of those maps is that they have facilitated discussion that hasn't taken place to date. Now we're talking about all solutions, comparing the cost of different technologies to address our future. Up until earlier this year, nobody was talking about cost allocation for transmission or whether the wind in the Upper Midwest was more economic than offshore wind in New Jersey. The discussion has moved forward.

Comment: Texas has been extraordinarily successful in adding transmission.

Question: If storage is such a great alternative to these other investments, at least in the interim, why isn't load doing it now? I mean why aren't big industrial customers making that investment inside the meter both to reduce their peak demand when prices are high and even availing themselves of the market at night? In ERCOT the prices between peak and off peak are pretty dramatic. Why don't they load up at night and use part of it? The industrials and the large commercials are very sophisticated customers, so that just tells me that the economics of storage really aren't there yet.

Speaker 3: They're not completely there yet, which is why we need the tax credits and other policies addressed to create better financial incentives. Because even CAES which has the best economics is still on the edge there. The stimulus funding needs to come to storage and have its effect on development as well. My sense is if we can put some of these subsidies in place and give it a real shot, we will emerge with a serious set of technologies that can hold their own in the markets.

Question: As long as gas is $3.50 none of this is really economic. It is clearly cheaper even to convert a dirty coal plant into a gas plant than to invest in green, or in storage.

Speaker 3: The CAES plants operate on gas. That's what runs them so there's the upside that the gas price is lower, but the downside is that the alternatives are cheaper. It's the combination of the change in the gas price, as well as the problems of the financial markets and tight credit that make it even more difficult. The stimulus programs are what will help this technology emerge.